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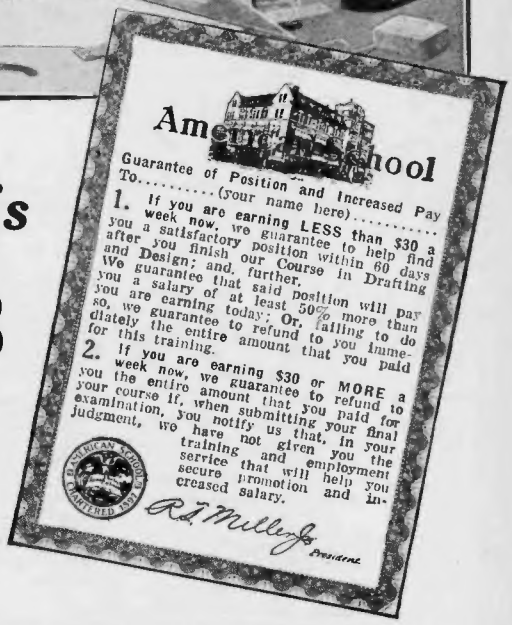
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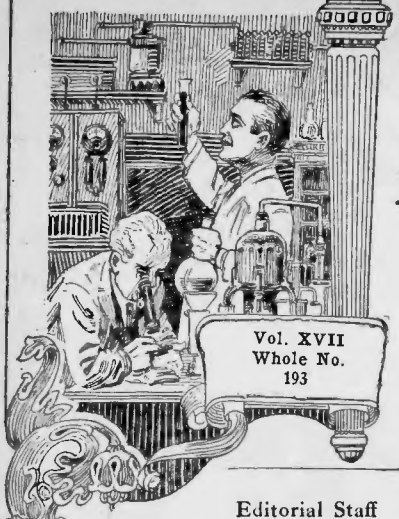

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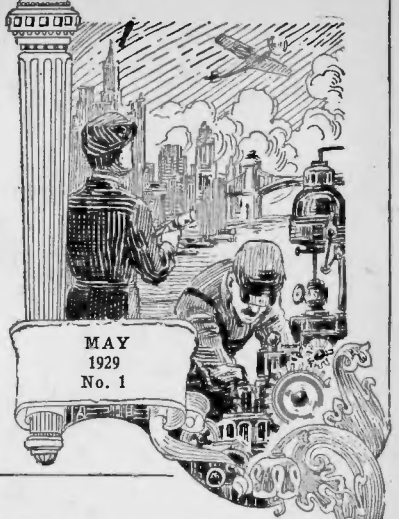

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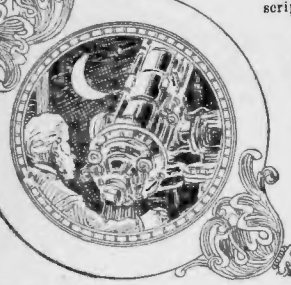

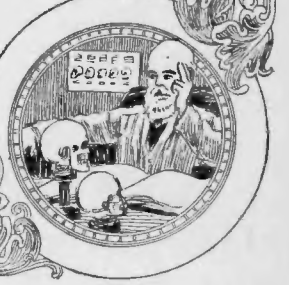

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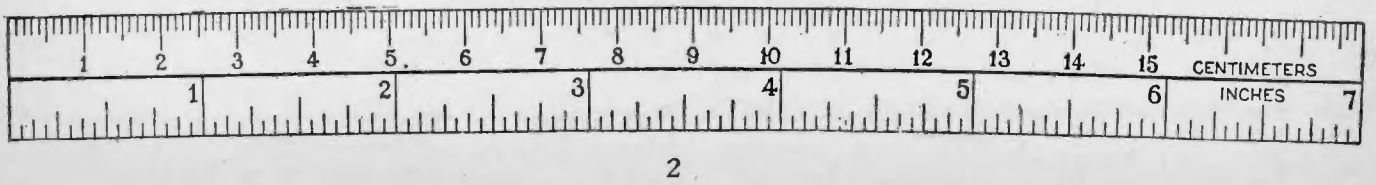

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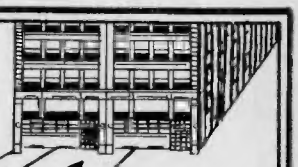

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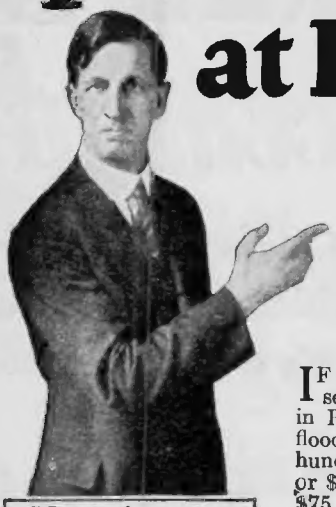

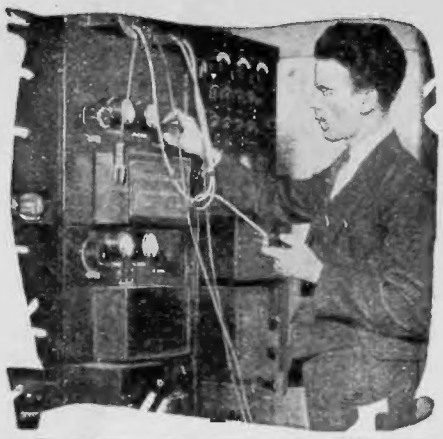

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Dept. 9-RT
National Radio Institute
Washington, D. C.

Here's the PROOF

Has Made $10,000 More in Radio

"I can safely say that I have made $10,000 more in Radio than I would have made if I had continued at the old job. When I enrolled with you I didn't know a volt from an ampere. I advise all ambitious young men to get into Radio. There is no greater opportunity."

Victor L. Osgood,
931 Cranford Ave.,
Bronx,
New York City.

$375 One Month in Spare Time

"Recently I made $375 in one month in my spare time installing, servicing, selling Radio Sets."

Earle Cummings,
18 Webster St.,
Haverhill, Mass.

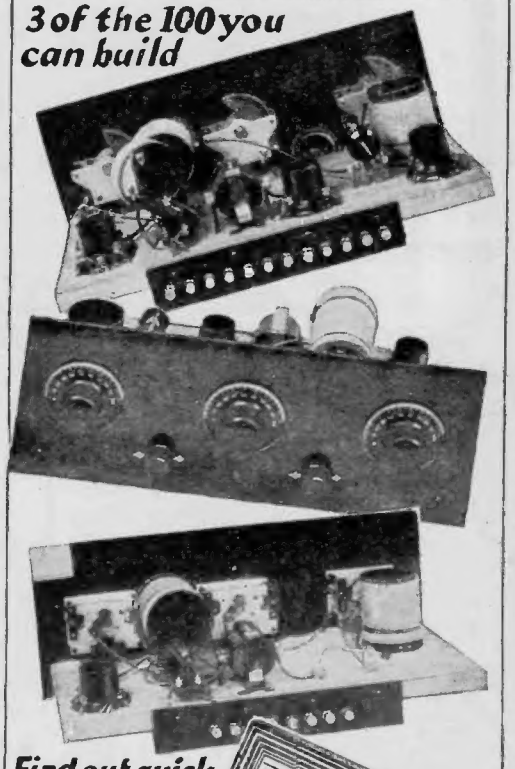
$450 a Month

"I work in what I believe to be the largest and best equipped Radio shop in the Southwest and also operate KGFI. I am averaging $450 a month."

Frank M. Jones,
922 Guadalupe St.
San Angelo, Tex.

You can build 100 circuits with the six big outfits of Radio parts I give you

3 of the 100 you can build



Find out quick about this practical way to big pay

Mail This FREE COUPON Today

J. E. SMITH, President
Dept. 9-RT National Radio Institute
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Dear Mr. Smith: Kindly send me your big book, "Rich Rewards in Radio," giving information on the big-money opportunities in Radio and your practical method of teaching with six big Outfits. I understand this book is free, and that this places me under no obligation whatever.

Name..... *Age*.....

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Occupation.....

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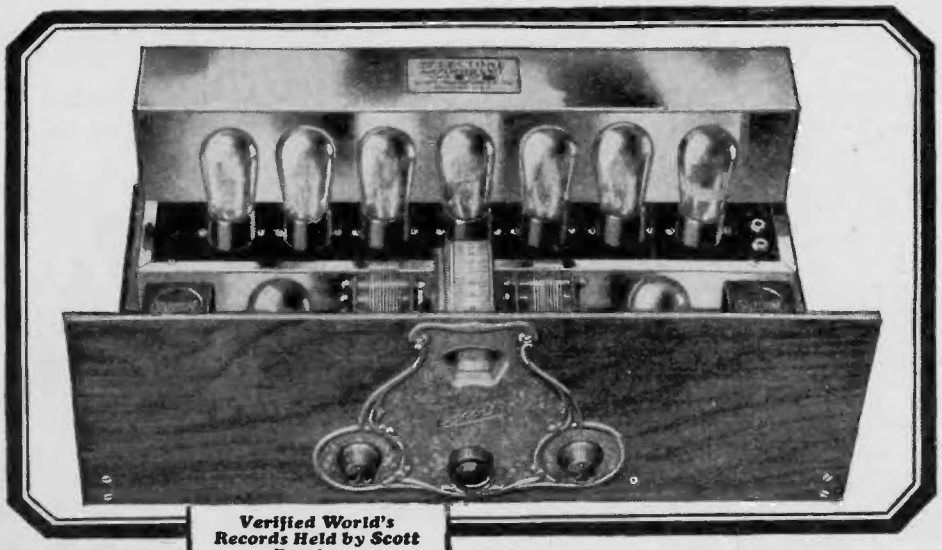
A Scott World's Announcement

E. H. SCOTT
Designer of receivers holding practically all the world's records.

and a policy of distribution which insures the purchaser's complete sat-



Verified World's Records Held by Scott Receivers
(1) A world's record for number of stations heard, distance 6,000 to 8,000 miles.
6 stations distance 6,000 miles.
7 stations distance 7,000 miles.
6 stations distance 8,000 miles.
(2) A world's record for greatest number of programs heard from stations distant 6,000 or more miles.
19 programs 8,000 or more mls.
19 programs 7,000 or more mls.
79 programs 6,000 or more mls.

THIS is the New Scott World's Record A.C. Nine with the Single Dial Control. The intermediate amplifier is completely shielded. The appearance of the receiver is that of the fine precision instrument which it is.

ONE DIAL *Control on the New* Scott A.C. Nine

The New Scott World's Record A.C. Nine which again repeats its unanswered challenge to the whole world of radio to equal its performance in any kind of competitive test, is now improved by the embodiment of *Single Dial Control.* Now, by merely plugging into your light socket and turning one small knob, practically any station within 10 kilocycles of any other station is brought in with thunderous volume and with vigorous, life-like, full-rounded tone. Anyone can tune the Scott World's Record A.C. Nine *now.* Anyone can fully enjoy its oft-demonstrated limitless range and revel in the endless parade of distant stations its brightly illuminated drum dial records. Thoroughly shielded—perfectly stable—no hum—using A.C. tubes—stations come in at only one point on the dial and always at the same point.

Truly, in all its history, radio has never offered so much as is available to you in this latest model of the one *proven* World's Greatest Receiver.

MAIL COUPON

Scott Receivers are designed for those who have tried other receivers and are now looking for something BETTER. They are custom built to your order and are sold only thru Radio Technicians carefully selected by the Scott Transformer Company. This policy of distribution puts you in contact with a man with years of radio experience and who has a thorough, practical knowledge of radio—who can supply you with a precision instrument that is guaranteed to outperform any other receiver available today—and who will take care of that instrument for you from the time of purchase. This policy eliminates all possibility of dissatisfaction on your part.

Send coupon TODAY for full particulars and for name of your local *franchised* SCOTT Representative.

The *New* Scott Symphony MODEL A.C. or D.C.

To meet the demand for a better performing custom built small receiver which is low in price but high in performance,

THE NEW 4 TUBE MODEL

the new Scott Symphony was created. One stage of Shield-Grid Amplification is used, making it the equal to many nine tube sets and is surpassed in general performance only by the new Scott World's Record A.C. Nine. One dial control—easily tunes out the locals and brings in distant stations. Engineered to the same quality standard as the nine tube model and backed with the same unqualified guarantee of superior performance and complete satisfaction.

Self-contained power supply in A.C. Model

The A.C. Model of the Scott Symphony is equipped with built in A.C. power supply which supplies filament, plate and grid current to all A.C. tubes used and the 171 A power tube. The D.C. Model is so designed electrically, that its current consumption is extremely low, thereby making it the ideal receiver for sections where A.C. current is NOT available or where it is desired to use batteries.

SCOTT

Send Today

Scott Transformer Co., 4450 Ravens Wood Ave., Chicago

Send me full particulars of ☐ Scott World's Record A.C. Nine ☐ A.C. Model ☐ D.C. Model ☐ Scott Symphony ☐ Scott Power Supply-Power Amplifier.
Also send me name of nearest franchised Scott Representative. EXP-G-5

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RECORD RADIOS of New 1929 Models

SC

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Professional Set Builders!

Scott Apparatus Now Sold Only thru CUSTOM SET BUILDERS

The custom building of fine radio receivers is *still* a profitable profession with our plan for those who are technically qualified, because there are thousands of people who want the best there is in radio and who know that the best cannot be produced by mass production methods but only thru the custom method of hand building.

This season Scott Products will not be sold direct to consumers nor thru jobbers, but exclusively thru professional custom set builders. We have adopted this policy because we believe in you and recognize the fact that your ability to deliver a far better receiver than any mass-production factory can make, and our protection of your market, will result in the growth of your business, and in turn, the growth of ours. Our line this season is complete and will enable you to supply a Scott receiver in a good console from as low as $90.00 to as high as $1,500. It embraces the Scott World's Record Shield Grid Nine, the Scott World's Record A. C. Nine, the Scott Symphony in both A. C. and D.C. models, and a line of cabinets which enable you to out-class, at the right price, anything else in the field.

We Help You Promote Sales

We have, ready to imprint your name thereon, illustrated advertising mailing pieces for you to use in spreading the news of your appointment as the franchised Scott Builder in your locality. Our 48 page book "How to Sell Good Custom Built Radio" tells you all about the Scott Plan and our proposition. It is the first and only complete, practical treatise ever prepared which clearly points the way to financial success for the Custom Set Builder. It is, however, sent only to those who can qualify and meet our standards as a Custom Set Builder.

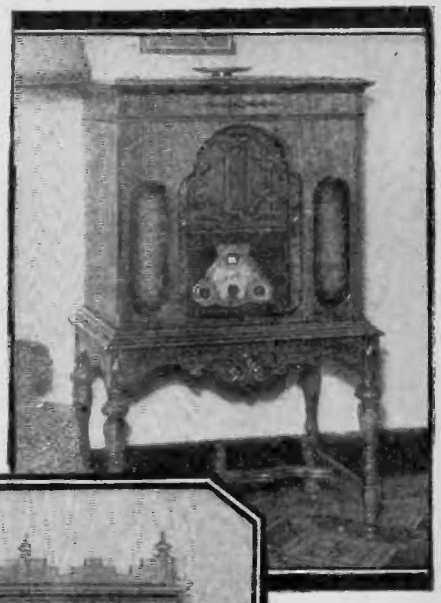
MAIL COUPON

For Qualification Blank

The Scott Franchise is, most naturally, a valuable one. Not only because of the obvious superiority of Scott Receivers, but because after you are appointed a Scott Franchised Builder, you will have taken a step towards establishing for yourself a REAL PROFITABLE business that will, with our co-operation and assistance, enable you to make more money than you ever dreamed was possible in the Custom Set building business.

Complete Line of CABINETS

Never before have we had a more beautiful or complete line of cabinets. They are the last word in "moderness" with sliding doors, rich selected walnut burls, hand rubbed finish. We show on these pages three of our ten different models and all are fine examples of the modern furniture craftsman's art. They will enable you to meet every cabinet demand from the most modest to the massive, rich, dignified hand carved console that will add distinction to the finest home. You can secure four of these consoles either with or without phono combinations. All are of the very highest quality and workmanship but are priced unbelievably low.



ABOVE: *The Taranaki*
TO THE LEFT: *The Canterbury*
BELOW: *The Milford*

Set Builders! **MAIL THIS COUPON**

Scott Transformer Co., 4450 Ravenswood Ave., Chicago
Send me details of your new models and Professional Set Builder's Qualification Blank and your proposition. I understand that your 48 page book "How to Sell Good Custom Built Radio" will be mailed me after I qualify. Exp.-G5

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Mammy Goes Home by Radio!

Steps right out thru powerful local Chicago stations,—and finds Birmingham, Alabama *with* New Radio Invention

"I Sho' was Happy!," says Mammy Jo

MAMMY JO was waiting up for us—her eyes rolling with excitement. She had been lonesome all day, she said. Even with her two small charges, and the radio for company, she was blue—just pining for a voice from home. We knew she used to try, time and again, to pick up broadcasts from Southern Stations, but without any success. However, that was not surprising; strong local stations had always smothered out distant ones on my radio.

"I think that Radio's gone crazy," now cried Mammy joyfully. "I just thought I'd find me some peppiah music to cheah me up, so I starts foolin' with the dials. Nex thing I knows, the announcah man says I's listenin' to Station WAPI, at Bummin'ham, Alabama—and thah I was, down in my Own Home Town! I listens to that station fo' a long time, and I sho' was happy. Dey ain't got music like dat up heah. No SUH! I sho' does think dat thing has gone crazy."

Subwave-Aerial Recommended by Licensed Radio Operator

"After thoroughly testing your Underground Antenna I find that it gives entirely satisfactory results. I would recommend it in place of inside aerials, roof aerials or loop aerials, for reasons of clearer reception, reduced pick-up of outside interference and static, easy and convenient installation and it is non-directional."

Yours truly,
Wm. Stringfellow.

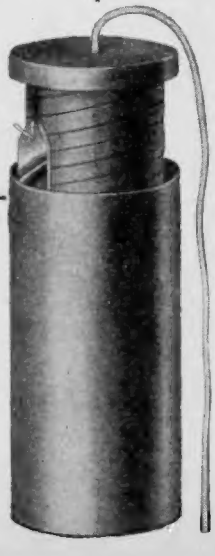
(Reprinted by permission of Mr. Stringfellow)

Ground Wave Reception

"No it hasn't Mammy," I laughed. "You've just been getting Ground Wave Reception with my new antenna, Subwave-Aerial. Until yesterday, I had my antenna up on the roof. That's why air noises and all the big powerful broadcasting stations we have around here in Chicago kept out-of-town stations away. Don't you remember, Mammy, you asked me yesterday why I was digging a hole in the ground under this window—and I told you I was digging up a new radio?"

"Yes Suh," grinned Mammy. "But does you all mean to say dat aerial business got me my home town?"

"That's right Mammy," I assured her. "You know it's the aerial that picks up radio waves and brings them to the set. When the aerial is in the ground, it's protected from a lot of interference. From now on you can probably go back to Alabama every night."



Reduces Static—Gets Clearer, Sweeter Tone

That was explanation enough for Mammy Jo. But when I told my friends about my amazing new underground aerial—how it reduces noise, gets clearer reception on both near and far stations, better selectivity too, and much finer tone—and that it didn't cost me a cent more than an ordinary aerial—and is guaranteed for 25 years—every one of them wanted to know all about it and try out a Subwave-Aerial.

YOU can test Subwave-Aerial FREE

When Subwave-Aerial can get results such as illustrated by the story above why let noise and interference keep you from getting distance on your radio?

Now you are given the opportunity to try out this wonderful new radio development without risking a cent. There's a new radio thrill in store for you! We feel confident that when you've heard the amazing difference in reception, and realize the great convenience of this modern combined antenna and ground, you'll wonder how you ever put up with the old, inefficient, dangerous method. Hurry and send for all the interesting details about Subwave-Aerial! Mail the coupon Today!

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Rush Illustrated literature on the new Subwave-Aerial and details of your Free Test Offer. No obligation to me.

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Volume XVII. Whole No. 193. **May, 1929. Number 1.**

Editorial

"Those Who Refuse to Go Beyond Fact Rarely Get as Far as Fact" - - *HUXLEY*

Radio and Aviation

AVIATION in this country is progressing with the same giant strides taken by the radio industry during the past few years. The development of air navigation and safety to life in the air will, to a large extent, depend upon engineering achievement in the radio field as applied to aviation. It is interesting to recall, in passing, that radio and aviation have been companion sciences from their earliest days. Prof. Reginald A. Fessenden, one of the most prolific inventors this country has produced, conducted much of his preliminary work on radio on Roanoke Island, just about three miles from where the Wright brothers were doing their first work with gliders at Kitty Hawk, at the same time.

The very great need for suitable radio safeguards for flying has been brought very thoroughly to the public mind by almost every long distance flight. The lack of suitable radio equipment made it necessary for the late Commander Rogers and his crew of the Navy flying boat to spend six horrible days adrift in the Pacific. Similar occurrences have been frequent, and their number is increasing. On the other hand, it has been possible for an airplane flying from California to Australia, to be in almost constant communication, either directly or through relays accomplished by steamships, with both the American and Australian continents. Even Lindbergh, in his flight, would have saved an interested, hopeful, but nevertheless fearful world much anguish if his progress across the Atlantic could have been followed by radio.

Flying the night mail has been made very much safer by radio beacons and other important radio developments. Commercial aviation may be benefitted in much the same fashion, and it is very likely that within the next year or two, the arrival and departure of airplanes at the various airports throughout the world will be greatly facilitated by the work radio engineers will undoubtedly do in that time. Commercial enterprises using the airplane for the transportation of their merchandise will be enabled to keep in touch with their own carriers at will.

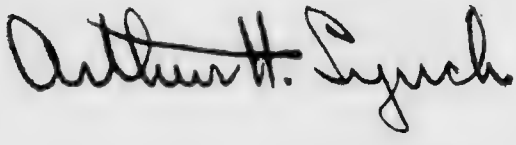
This rapidly growing field of enterprise is one which should intrigue the interest of every forward-looking radio engineer. We believe that a great many of the men who have contributed greatly to the science of radio are interested in aviation, and with this idea in mind, we contemplate including in Science and Invention and Radio News—two of the scientific publications in the Experimenter group — sections devoted to flying.

There is at present, a very rapidly growing interest in the motorless machines called *gliders*. Most of the preliminary work done by the Wright brothers was done with gliders. People who are devoting their attention to the development of the air industry throughout the world are very keenly interested in the glider, from the standpoints of study, pleasure and profit.

We have been very fortunate in securing for the contributing editor to both of our publications for aviation, Mr. Augustus Post, who was for twenty years Secretary of the Aero Club of America, and who, as far back as 1914, made the following prophecy of Lindbergh's flight to Paris:

"A man is now living," he wrote, "who will be the first human being to cross the Atlantic Ocean through the air. He will cross while he is still a young man. All at once Europe will move two days nearer; instead of five days away, it will be distant only thirty hours. . . . It would seem out of keeping with the general economy of weight, when even the parts are not duplicated, that the pilot should be carried in duplicate. . . . As for keeping awake and alert for the whole time of flight, every aeronaut knows that this is possible. . . . Whoever crosses the ocean through the air for the first time will be too busy to be lonesome!

"Imagine, then, the welcome that awaits the Columbus of the Air! The cables warn of his departure, before him flies the wireless announcing his progress. Ship after ship, waiting the great moment, catches glimpses of the black dot in the sky; ocean steamers, bearing each a cityful of human beings, trains thousands of glasses on the tiny winged thing, advance herald of the aerial age. . . . Above all he rides, solitary, intent. There will be no time to decorate for his coming; flags will run up hurriedly, roofs in an instant turn black with people, wharves and streets white with upturned faces, while over the heads of the multitudes he rides in, to such a shout as the ear of man never heard. No explorer ever knew such a welcome, no conqueror, as awaits the Columbus of the Air."



Editorial Director.

The Editors will talk each week from Stations WRNY (297 meters) and W2XAL (30.91 meters) on scientific subjects.

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THE ORIGIN

BY DR. ALEŠ HRDLIČKA

Dr. Ales Hrdlicka, M.D., noted anthropologist of the U. S. National Museum, at Washington, D. C., the author of the present evolution article.

The Theory of Evolution Outlined for the Layman

THIRD ARTICLE

I.—Fundamentals

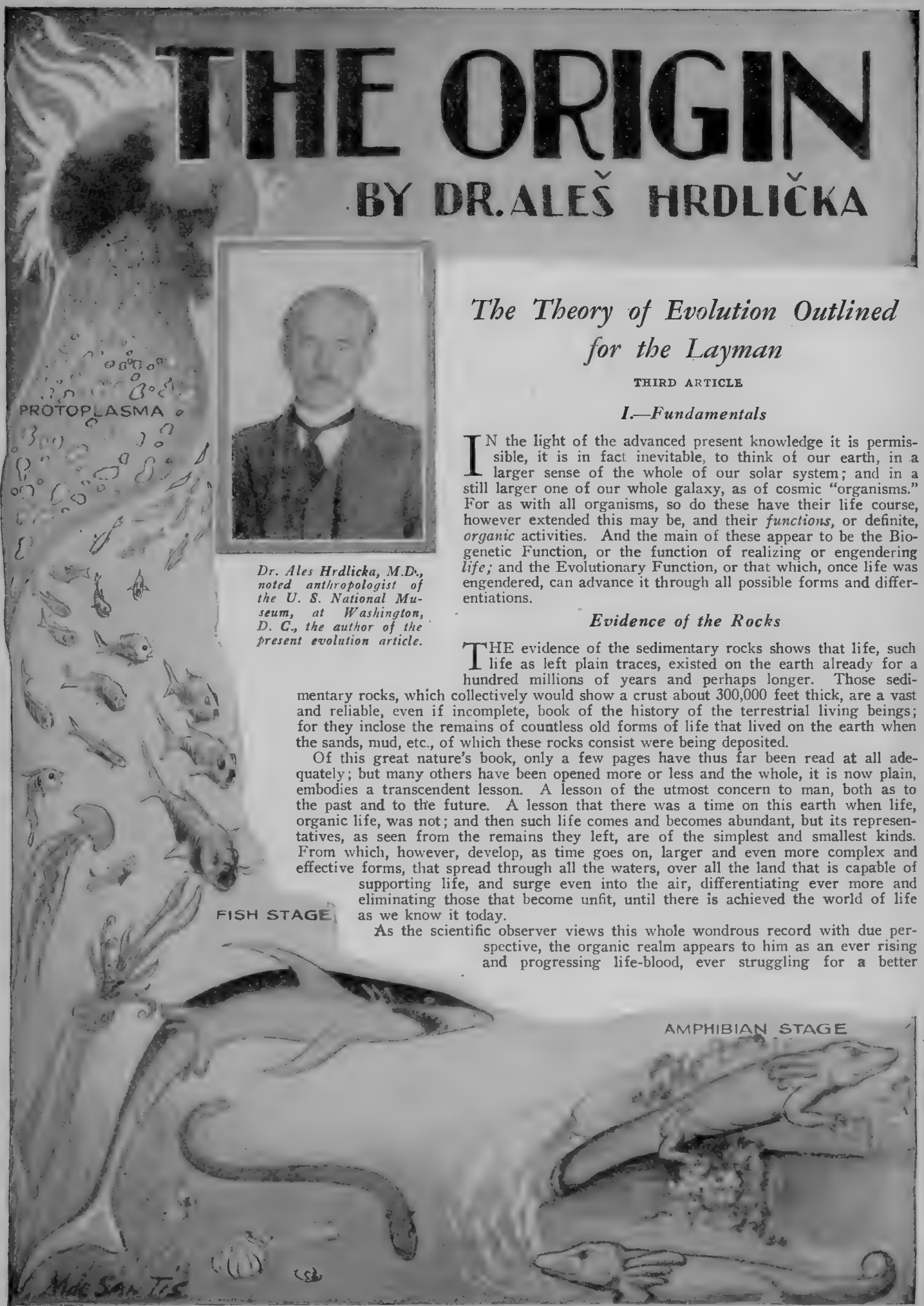
IN the light of the advanced present knowledge it is permissible, it is in fact inevitable, to think of our earth, in a larger sense of the whole of our solar system; and in a still larger one of our whole galaxy, as of cosmic "organisms." For as with all organisms, so do these have their life course, however extended this may be, and their *functions*, or definite, *organic* activities. And the main of these appear to be the Biogenetic Function, or the function of realizing or engendering *life;* and the Evolutionary Function, or that which, once life was engendered, can advance it through all possible forms and differentiations.

Evidence of the Rocks

THE evidence of the sedimentary rocks shows that life, such life as left plain traces, existed on the earth already for a hundred millions of years and perhaps longer. Those sedimentary rocks, which collectively would show a crust about 300,000 feet thick, are a vast and reliable, even if incomplete, book of the history of the terrestrial living beings; for they inclose the remains of countless old forms of life that lived on the earth when the sands, mud, etc., of which these rocks consist were being deposited.

Of this great nature's book, only a few pages have thus far been read at all adequately; but many others have been opened more or less and the whole, it is now plain, embodies a transcendent lesson. A lesson of the utmost concern to man, both as to the past and to the future. A lesson that there was a time on this earth when life, organic life, was not; and then such life comes and becomes abundant, but its representatives, as seen from the remains they left, are of the simplest and smallest kinds. From which, however, develop, as time goes on, larger and even more complex and effective forms, that spread through all the waters, over all the land that is capable of supporting life, and surge even into the air, differentiating ever more and eliminating those that become unfit, until there is achieved the world of life as we know it today.

As the scientific observer views this whole wondrous record with due perspective, the organic realm appears to him as an ever rising and progressing life-blood, ever struggling for a better



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OF MAN

Indisputable Facts Reveal Man's Origin

accommodation to and more mastery over conditions, and changing in accordance. And that progressive changing is—"evolution."

The most remarkable character of this *function* or process of evolution, is its apparent order. With the growing discernment of science, it is seen to have been and still to be no haphazard chaos of happenings; but a swarm, a tide, or, better still, a progressive unfolding, blossoming out, of definite connected phenomena and laws, showing nature immeasurably richer and more potential than ever conceived before.

Through the collections from the rocks, through observation of what is now going on in nature, and through experimental work in many laboratories, the essentials of this amazing process of organic evolution are slowly becoming known. Among them are seen, on one hand, nature's conservatism, with on the other hand an ever present variability in the living forms; persistence, yet with ever budding divergence; gradual acquisition of slowly gained or needed characters, with an occasional seeming jump or sudden change, a mutation; ruthless elimination of those who become unfit, but healing everywhere of the merely damaged; and an ever greater accommodation, where a mastery of the environment by the progressive forms of living beings, with greater sensitiveness, effectiveness, individuality, and "mentalization."

It may easily be understood why, the more clearly it is known, the more all-important and surpassing this process of evolution of terrestrial life looms up; and why the more humble, and deeply appreciative, before "Nature" with all its potentialities its privileged observers stand.

The material evidence of organic evolution as recovered from the rocks, very incomplete as it still is, leads already to some sound generalizations. The principal ones relate to the sequence of all events.

The earliest *living* forms, according to all indications, must have been exceedingly simple and perishable, as they left no traces of any sort that can now be identified. Life began, it would seem, in something like a molecular form, long before the first cell was reached; for the cell was already a high accomplishment in evolution.

The formation of what could be called a *first cell* marked the beginning of living one-cell *organisms,* such as represented to

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The change in man during a few thousand years is mostly in the matter of dress.

this day by bacteria, amoebae, the simplest *diatoms.*

The First Life Cell

THE next step in evolution *was the combination of two or more cells into units, with commencement of subdivision of function among the different cells;* and from these forms arose a variety of many-cellular organisms that eventually differentiated, on one hand, into the primitive *plants* and on the other hand into the early *invertebrates.* It is at this stage that there is the first clearer cleavage of the living beings into the vegetal and the animal kingdoms. The identifiable remains of organic beings begin at about this stage, never to cease henceforward.

The ancient remains of this nature show that gradually, in long stretches of time, there developed from among the lower forms, higher invertebrates and plants, then insects and primitive fishes, then higher fishes and amphibia, to be followed by aquatic and then land reptiles, by pterodactyls and birds, and finally by the mammals, the animals in which the mother nourishes her not fully fledged progeny for a shorter or longer time after birth, with the milk of her breasts or mammae.

In all of this there is seen everywhere a general lawful progress, and never a regression of any organism to an earlier, lower grade. The older outlived forms pass away, but there arise ever new and more capable species or genera. In ill-favored groups there may be brutalization or degeneration; there are forms that seem to stop for long periods, or even retrograde in part, while others progress onward; but there is never evolution backward, return to forms that have already once existed; nor was there ever, so far as known, an evolution of any one form on more than one occasion.

During the so-called Cainozoic or Tertiary era, the age of mammals, certain evolutionary manifestations begin to assume a special interest to science. There are seen to have developed, from among the strains of certain smaller mammals, creatures that are noticeable by characteristics of their forelimbs, teeth, position of the eyes, etc., that more than any features before, tend to foreshadow those of man. In recognition of that this order of beings is called the "Primates."

These primates begin apparently very humbly with certain tree shrews; but before long and still in the Eocene or Dawn-period of the Tertiary, there appear lemuroid forms, then true lemurs, and then smaller tailed monkeys. These in turn are seen from the fossil remains to have advanced, in the Miocene and Pliocene or the two latter periods of the Tertiary epoch, towards larger monkeys, and eventually towards the anthropoid or manlike tailless "apes," who in many respects, as their name implies, more closely resemble the form of man.

All this is no more mere theory but a matter of much material evidence, for many of the forms here mentioned are more or less known now through actual fossils from Asia, Africa, Europe, and to some extent even from America. During the latter half of the Tertiary, the anthropoid apes extend already over most if not all the farmer regions of the Old World, and some of them, especially in teeth, come very close to the human.

After this, suddenly, something wholly new begins to occur on this earth. In one at least of the large areas that had been occupied by some of these anthropoid apes, and possibly in more than one, there are now known to exist, in the sands, clays and gravels of these faraway periods, in company with fossilized remains of long extinct elephants, rhinoceroses, lions and other animals, flints that show intentional, objective, purposeful chipping. Some creature has developed which has "hands" full-fledged enough to do the chipping and to use the resulting tools or weapons, with mentality enough behind to appreciate the advantage of such artifacts, to make them systematically, and to use them for definite services. Nothing even approaching this has ever happened before on the planet. There is plainly a new form of existence, a beginning of beings with enough mentality to advance to "cultural" manifestations.

And from this time on the evidence of these new beings never ceases, but augments step by step, extending over many lands. The artifacts keep on developing in workmanship and variety, until, well before the middle of the Ice Age, they reach a status that is already clearly "human." There has come into being that supreme triumph of all—A Man.

DO YOU NEED A COLLEGE EDUCATION?

THE next series of feature articles presented will deal with the value of a college education. The opinions of many noted individuals engaged in diversified fields of endeavor have been obtained.

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The evolution of dress illustrates changes in man's customs and mode of living.

Soon after this period there come to light skeletal fragments of these new beings. They are still crude, very primitive, in many details still largely anthropoid, but in essentials already unmistakably "human." In approximately a quarter of a million of years evolution has produced, from some group of precursors, a true, even if yet crude, Man. Man, however, of still so low order at first, physically and mentally, that it takes him another quarter of million years to reach a status comparable to that of the most primitive groups of humankind of today.

Meanwhile the more direct ancestors of the "humans" all perish. There is nothing left but several species of more or less distinct cousins, the living anthropoid apes. Even of man, it is reasonably believed, the earlier branches have died off, leaving eventually but the most fit, the posterity of which, differentiated into many "races"—themselves examples of evolution—survives and carries on as the present day humanity.

Thus speak, in very brief, the records of nature, and from them science endeavors to piece together the true story. The story is still far from complete. It is still but a mere sketch of the facts, with the details to be discovered and filled in. But it is already a substantial, documented sketch which year by year is becoming richer and more wonderful and beautiful.

Meanwhile, long before many important facts of natural history were known, meditating and impatient humanity, on the basis of ages of imperfect observation and consequently defective intuition, formulated itself various notions of Man's origin. The earlier thinkers found man seemingly so isolated and at the same time already so superior to all other creatures in mentality and brain power, that they concluded he must have been the product of a special creation. These notions, the best then possible, became eventually both venerable and "sacred." They became ingrained in men's minds and are not easily replaced by newer scientific facts. They became deeply habitual, men's minds have got attuned to them, they are part of present man's mental heritage, and working systems of "morals" have been built up on their basis. Moreover, even today, only a small proportion of men are so situated as to become acquainted with anywhere near the full scientific evidence bearing upon the question. What wonder, therefore, that human evolution is not yet well understood by the masses and that, calling as it does for a profound even if most promising mental and other reaccommodations, it is resisted. Knowing well the only too apparent frailties of our mind, placed on their guard by the fate of many a genial theory, and not knowing or having a chance properly to learn the real facts, what wonder that otherwise sound conservatism combats the new views.

Among the opponents of evolution there are many earnest men and women who are deeply distressed, rather than militant; who with all their might seek for truth; but who, due to their conditions, are not able to learn the full truth and therefore cling to what has the sanction of time and their teachers. Besides these there are some who have become deluded into believing the new views to be artificial and mischievous, and these combat the supposed threatening evil. To all of which there is but one effective remedy, which is enlightenment. The moment science can show, to the spiritual and educational leaders of the people, all that it already knows itself concerning organic and human evolution, from that moment there will be little difficulty about the acceptances of the teachings of human evolution, and the needed mental readjustments will be made as easily, as they are being made in regard to other great natural truths.

Science the Servant of Man

SCIENCE is no separate entity in humankind, it is its product and best servant. If it discovers any new facts it is its duty to present them. If it has not yet been able to do so adequately in relation to organic and especially human evolution, it is because it was not, is (*Continued on page 89*)

Our artist's conception of the future man and woman is illustrated here.

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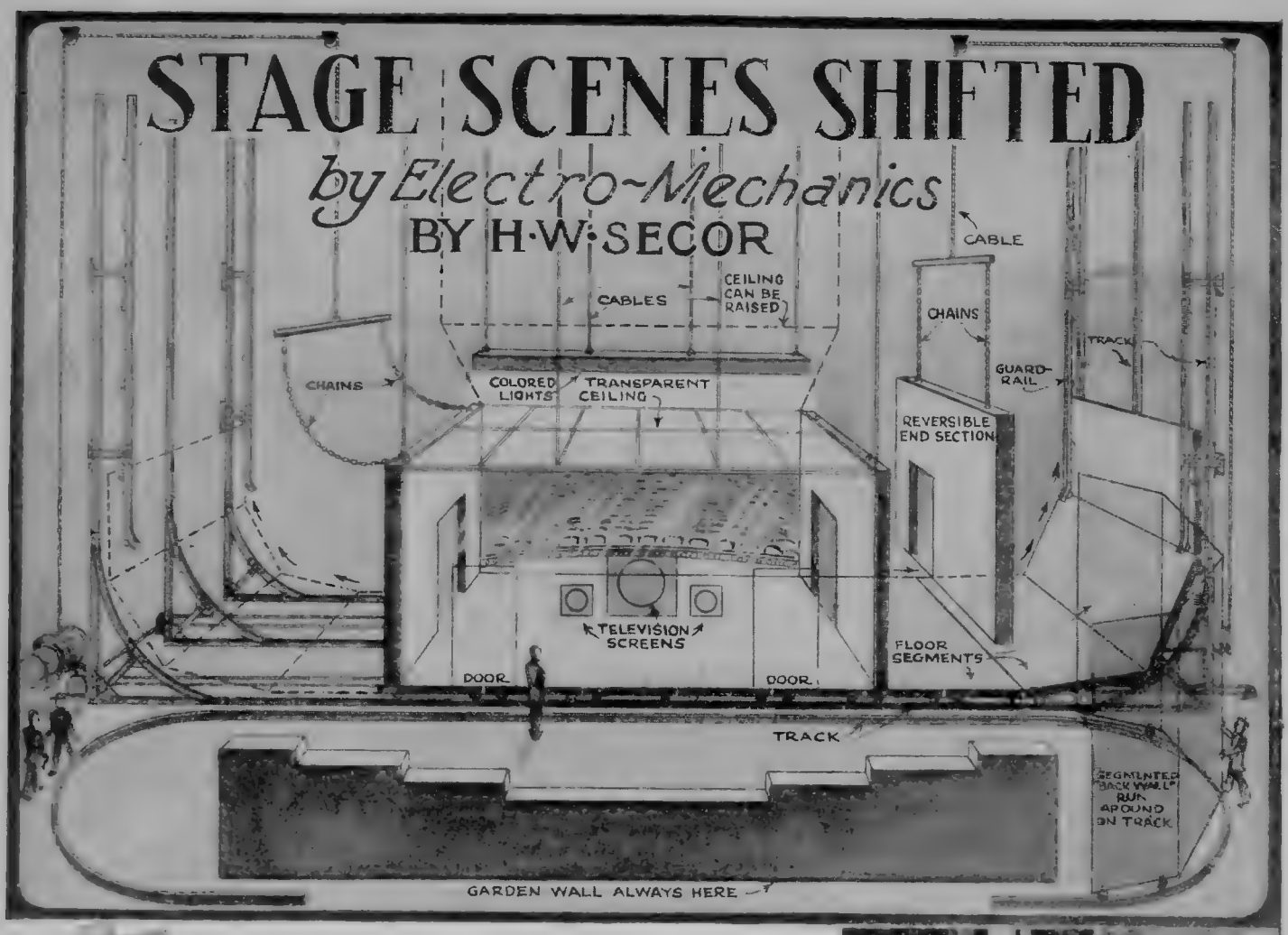
STAGE SCENES SHIFTED

by Electro-Mechanics

BY H·W·SECOR



A view from back of stage, looking toward the auditorium, in the New York production of "Tomorrow," a play of the future. The jointed floor rolls up the tracks at either side of the stage, as the room scene changes. A single electric motor, by means of cables, causes the scenes to move as indicated.

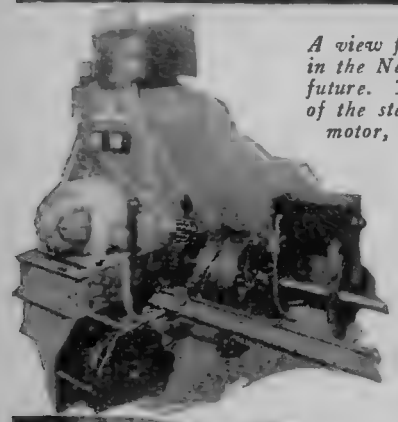


Photo above, at left, shows control switch and speed regulator, together with motor and cable winding drum for changing scenes. Scene below at left shows arrangement of tracks up which the jointed floor rolls. The back scene moves on wheels along the track shown.

"Tomorrow"—A Remarkable New York Theatrical Production, in which the Scenery Was Shifted by Operating a Single Electric Switch

ONE of the most refreshing productions seen in New York City in a long time was the show *Tomorrow*. This play *Tomorrow* proceeded to show how we will live 50 years from now. To open a door, order a meal, and to accomplish dozens of other things, one has simply to speak a certain code number to a radio transmitter disk worn on the wrist. Fifty to seventy-five years from now, we may live in such a perfect Utopia, where we shall summon a servant or order the family helicopter, by giving voice to our desire through the medium of a certain pre arranged number or code word. At the present time we have a number of sound-operated telemechanisms, for instance the voice-operated toy dog, which comes out of his kennel when the command "come out" is spoken. Then we have the famous *televox*, which executes a considerable number of commands by means of certain sounds sent over the telephone line, and toy railroads, several years ago, were started and stopped by a special voice-control relay.

Above, we see the close-up view of curved vertical track with jointed floor being pulled up along the track. One of the room end scenes is to be seen rising simultaneously.

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In one of the scenes, a pair of hands are observed playing on a piano keyboard in a vertical position through a "television" window. How this mystical scene is staged is clearly shown above. Scene at right shows how face is made to grow larger in "television" screen.

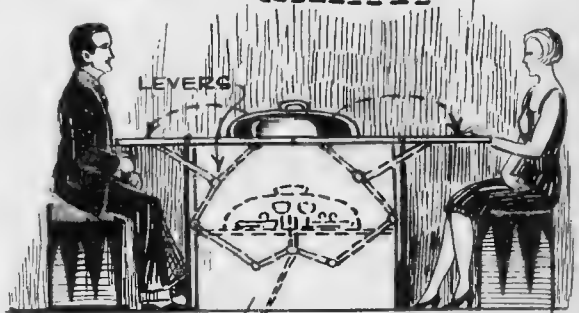
Elaborate helicopter flying machine used in "Tomorrow." It cost $4,000.

The flying machines shown in the play *Tomorrow* were quite elaborate affairs and one of them is illustrated herewith. The larger of the two models appearing in the play cost about $4,000 and is fitted with electric lights, while the tail and roof propellers were driven by electric motors. A brand new arrangement of the stage scenery was worked out and produced under the direction of Mr. John Ashley, and the general idea behind his scheme for progressively changing the scenes is made apparent by a study of the illustrations here presented. The audience had the unusual experience of seeing the actors walking from one room to the next, through a door, while room No. 1 was disappearing off the left of the stage and room No. 2 was coming onto the stage.

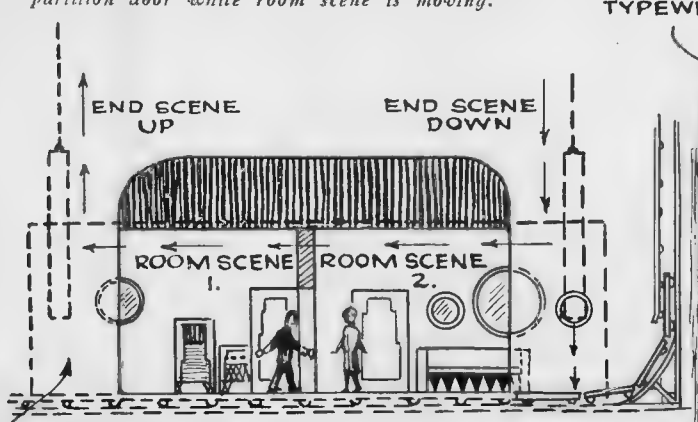
Jointed Floor Curls Up

THE long jointed floor rolled along on rubber-tired wheels in grooved steel tracks, the movable floor being pulled by cables secured to a motor-driven drum, the motor being controlled by a single reversing switch and a speed controller, shown in one of the pictures. While the floor sections roll along and up the vertical tracks, at either side of the stage, the corresponding end wall of the room is automatically pulled upward about twelve feet to allow the actors room to pass under it. The *rear wall* scenes, as the illustrations clearly show, move along the curved stage floor tracks.

(*Continued on page 67*)



Pictures at right show how meal is served at word of command, and how letter is written by a "voice" operated typewriter. Below, how actors walk through partition door while room scene is moving.



FRONT VIEW SHOWING ACTORS PASSING FROM ONE ROOM TO NEXT WHILE SCENERY MOVES ACROSS STAGE

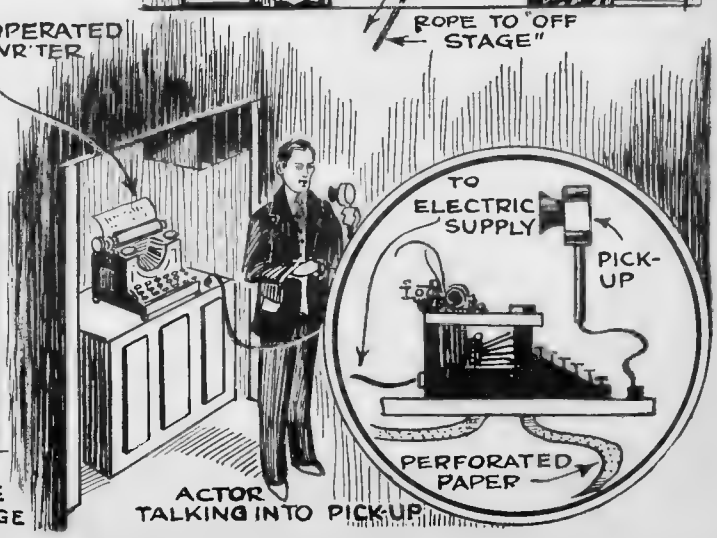


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Fig. 1. When taking a course to become a policeman, you are shown a photograph similar to the one above, which illustrates a fire department's equipment trying to make a connection with an automobile parked in front of the hydrant. Look at this picture carefully, then see if you can answer the questions about it asked elsewhere in the article.

What Kind of a Policeman

COULD YOU QUALIFY AS A COP?

By UTHAI VINCENT WILCOX

IF you have a scowl, a grouch, and a day utterly ruined, because the traffic cop bawled you out this morning when driving to work; if you feel that it would make you supremely and radiantly happy to be able to sock John Law a regular Dempsey hay-maker—if you only dared—and you don't; why cheer up!

Chuckle over this: the police are having troubles of their own, and a-plenty. Between learning how to shoot straight, first aid lessons, gymnasium instruction and keeping up with all the new laws and reading the reports of all the men wanted, they must be able to pass several score metal tests made up by some of the nation's shrewdest scientists.

Since you are not apt to weep over this, you can still be thankful you are not a cop. Just try a few of these tests out on your own brain cells:

"Wilson, at 3 a. m. seeing the door of Johnson's coal office open, enters same and steals $34.95 from the cash register. Does Wilson commit robbery, burglary, embezzlement or mayhem?"

Or thus: "If you found a person dumping garbage in a vacant lot and you were a policeman, what would you do? Suppose this lot contained dead animals—what would you do then?"

But such questions are easy, comparatively. John Law has to do more than merely answer from his manual. He must have a good memory for details. He must be able to size up the situation and know what to do next. He must be able to testify in court as to a hundred factors of an accident.

This is all a part of the training of the new policeman. And just to make the tests harder, more complete and uniform there is an organization at Washington, D. C. known as the Bureau of Public Personnel Administration where such practical scientists as W. F. Willoughby and Fred Telford assisted by nineteen technical experts from as many leading scientific institutions who have correlated the results of all previous tests and according to the answers have steadily raised the standards—and made them harder.

Tests

THERE is Test One, which is designed for Accuracy of Observation and relates to automobile accidents. Your friend, the patrolman is given a print showing the drawing of an automobile which has been struck by a street car like Fig. 4. This is placed before him face down.

The Chief or the Commissioner or the Inspector standing before his blue-coated class of husky Sullivans says: "The sheet face down on the desk before you is a drawing of an automobile accident. When I give you the signal you are to turn over this sheet and study all you see in the drawing for 1½ minutes by my stop watch. The sheet will then be taken up and you will be asked to answer 15 questions about the accident.

"These 15 questions will be about such things as the time and place of the accident, how it occurred, what damage was done, and other facts such as a patrolman ought to know, so he can make a report to his superior officer. If you wish to, you may make notes about the things you see in the drawing and use these notes in answering the questions which will be asked later.

"Remember now that you are to have just 1½ minutes to study the drawing and that you will have to answer 15 questions about the drawing from memory or from your notes. Are you ready? Then turn the sheet."

Fig. 2. Here are photographs of ten people whose faces are to be remembered. Look at this print for exactly one and one-half minutes, then permit two hours to pass. At the end of two hours, look at the illustration on the third page, Fig. 5, and see if you can locate among the 48, the ten faces here illustrated.

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Would You Make?

DON'T think that the life of a policeman is entirely rosy. Aside from learning how to shoot, how to administer first aid, how to outpoint a man much stronger than himself, how to keep up with new laws, and when to arrest and not arrest a man, the policeman must pass several score mental tests made up by the nation's shrewdest scientists. Just try a few of them, and then see what kind of a minion of law and order you would be.

Fig. 3. This is another test for observation and memory which includes the vexing problem of automotive traffic. You may look at this picture for one and one-half minutes, observing all of the details. At the end of that time you will be asked ten questions concerning it. The questions are found in the text. This is only one of the tests to which a policeman is put.

It sounds easy. One and one-half minutes! Time up. A few minutes later a sheet with 15 questions appears and just 7 minutes are given to answer them, about two minutes per question.

You might try it yourself. The questions appear in the box on page 18

And speaking of automobiles the patrolman must have good eyes coupled with a good memory. The Commissioner's examiner plays a serious little game of automobile tag numbers to find out. If John Law can't keep up well, he's out of luck. He either has to hunt a new job or pound the pavements out in the fog belt where there are a lot of long stretches of good walking streets and the nights are cold and the days hot. Commissioners have their own sense of humor.

Here's the automobile tag game in all its reality: There is a device that appears as a rack and has a series of automobile tags capable of being changed and covered up. The patrolman sits about ten to twelve feet away where he can see clearly and easily. The Examiner then makes his speech:

"I have here 11 automobile tags which will be shown you one at a time for two seconds each," he says.

"When the first is exposed you are to note the number, the state, and any other identifying letters or marks. After the tag is covered you are to write in your booklet all the marks on the tag. Then a second will be shown you and a fourth, and so on until you have observed and recorded all 11.

"The first one will be practice and will not count. Are you ready?" Then by means of a camera bulb timing device such as is used to take pictures, and a stop watch the numbers are shown for the exact two seconds, no more and no less.

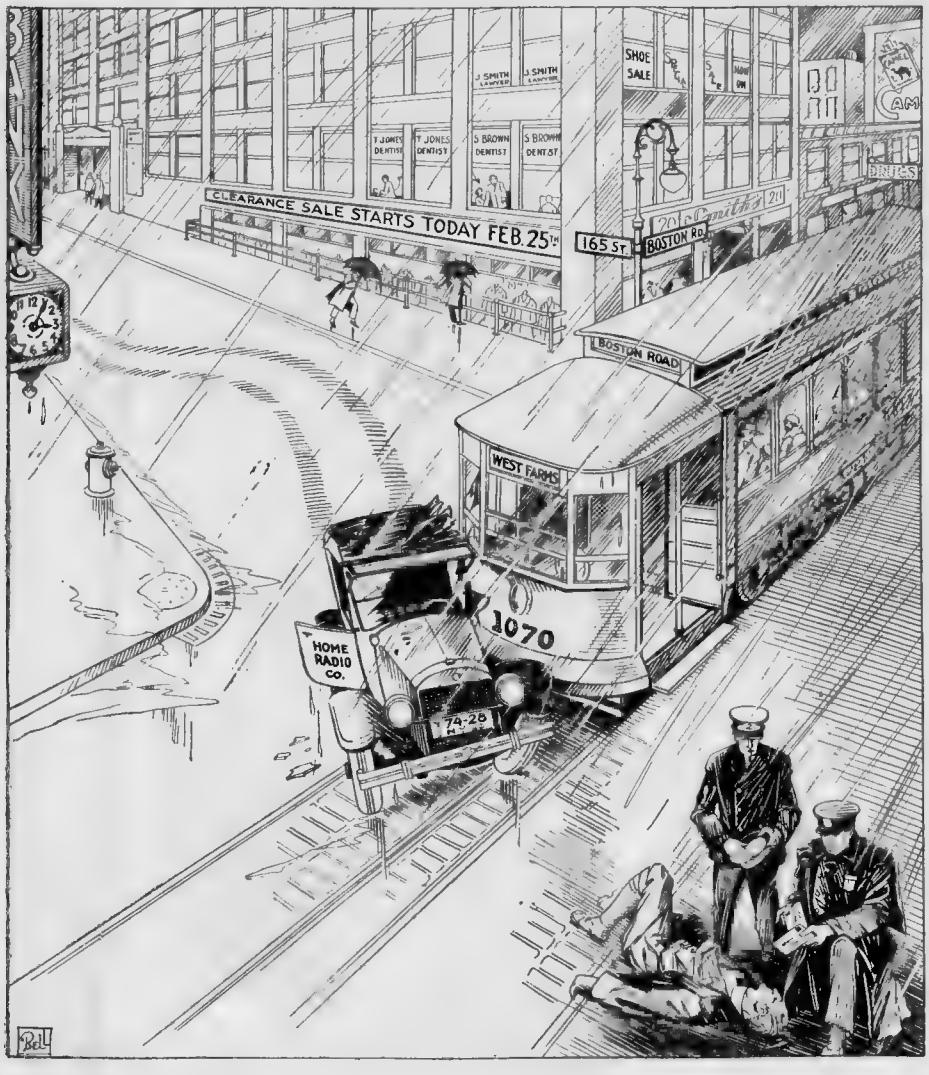

Fig. 4. Study this illustration for one and one-half minutes. Make any notes that you care to. Then turn the page, and see if you can answer the fifteen questions asked about this illustration. A good policeman can do so. What kind of a policeman do you think you would make? See for yourself.

Average Tag Visible Two Seconds

WHY the two seconds? It seems that science has discovered that two seconds is the average length of time that a machine number is visible on the street under average conditions.

This automobile tag game is played through to the end. It is considered a stiffer test than the accident illustration, for while the patrolman can write down the number immediately afterwards, he must see accurately and quickly. He has no time to say it over a dozen times in order to remember. He has got to see and know! See figs. 6 and 7.

These are accuracy observation tests, remember. If they sound like memory tests then what about Test 2?

The officer: "You are to answer five questions from the following order, but when I read it you are not to make any marks or notes." He then reads slowly and distinctly:

"Beginning at midnight next Monday all patrolmen will report for duty in summer uniforms. Commanding officers will inspect each squad before the men go on duty and report to headquarters any failure to comply in full with this order. Any patrolman reporting in uniform not in accord with the specifications will be dealt with as required in the regulations unless he gives an explanation satisfactory to his Captain." (*Continued on next page*)

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CAN YOU ANSWER THESE QUESTIONS?

The questions here are all about Fig. 4 on the previous page. Having looked at this figure for one and one-half minutes by a stop watch, answer the following:

1. At what street intersection did the accident occur?
2. What is the condition of the weather?
3. From what state is the automobile?
4. On which side was the automobile struck?
5. About what hour of the day did the accident occur?
6. Name three ways in which the automobile was damaged?
7. What is the number of the street car?
8. To whom does the automobile belong?
9. Name two things which show the driver lost control of the automobile?
10. What is the route of the street car?
11. What is the number of the street car employee?
12. What is the date of the accident?
13. Name two things which indicate that the chauffeur was killed rather than only injured?
14. Who is the first person you could call as a witness of the accident?
15. How is the policeman attempting to identify the chauffeur?

Could You Qualify as a Cop?—Continued from previous page

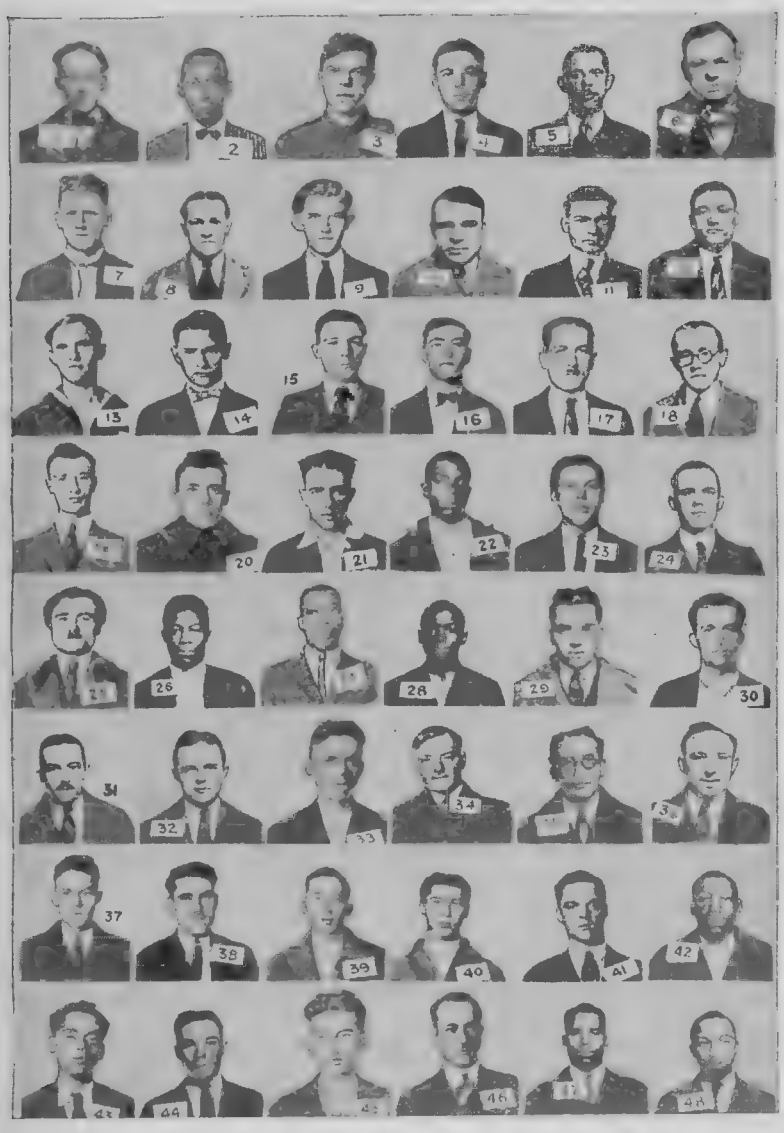

Fig. 5. Somewhere among the 48 faces are the ten faces shown on the second page previous. How many of them can you find? A lapse of two hours should have occurred between your inspection of this illustration and Fig. 2 previously mentioned.

Which sounds dead easy. But there are the five questions to be answered in no longer time than two minutes from memory of the oral order just read:

1. To whom does the order apply?
2. In case any patrolman is not in proper uniform, what action is to be taken?
3. By whom is the inspection of the uniforms to be made?
4. When are the uniforms to be inspected?
5. On what day does the order go into effect?

Individual Test

THAT is merely to warm them up. There then follows the famous description of the individual test. A sentence such as, "Look for Mike O'Connell, wanted for burglary. He is 5 feet 11 inches tall, and weighs 132 pounds. He has dark brown hair, grey eyes, fair complexion and a scar on the forehead. Two of his upper front teeth are broken. The little finger of his right hand is missing."

The Examiner allows no notes. All must wait three minutes and then write down 10 facts from the description of Mike O'Connell. This is similar to a telephone description or a special warning sent out to police stations.

There follows the matter of faces: If you can't remember names then you can easily remember faces. But can you? The youth Hickman was wanted for murder in California. He was on his way from Los Angeles to an unknown destination. A wired description of his height

(*Cont. on page 78*)

Fig. 6. Automobile license tags are arranged in a rack as here illustrated. One by one a tag jumps into position in front of the opening for an observation period of but two seconds.

Fig. 7. This is a front view of the device illustrated in Fig. 6. The shutter arrangement permits of a two second observation period.

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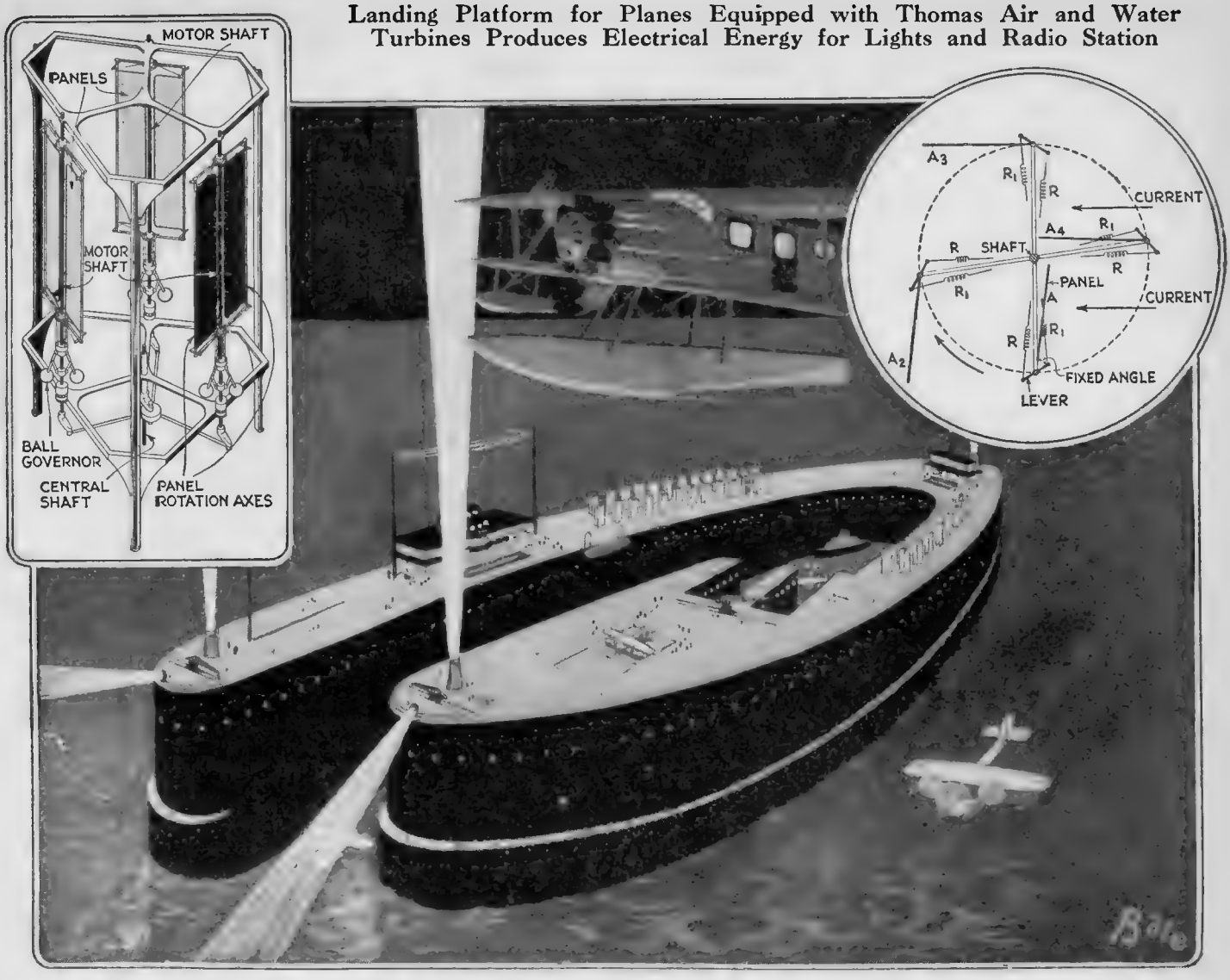
Landing Platform for Planes Equipped with Thomas Air and Water Turbines Produces Electrical Energy for Lights and Radio Station



The above illustration shows a proposed ocean landing platform for airplanes. The wind turbines may be seen.

A top view and a side view showing the construction of the generator turbines appear in the insets.

MID-OCEAN AIRPLANE STATION GENERATES OWN POWER

THE invention of the Thomas wind and water turbine opens up a new field for the development of natural power. Boats equipped with these turbines are enabled to generate their own power, resulting in a saving of money, besides simplifying the installation of propelling mediums. The same turbines can be used on land for generating electrictiy at an extremely low cost.

A mid-ocean landing platform for aircraft using the new invention has been proposed by the French magazine *La Science et La Vie*. This seadrome is shown in the illustration and generates its own electric power for operating the searchlights, landing lights and the radio station, which may be seen on the left-hand section of this peculiarly shaped floating haven for aircraft. The land planes will alight on and take off from the largest section of the "U" shaped float. The water enclosed by the floating airdrome provides a harbor for the seaplanes. Life boats are arranged at intervals along the landing platform and the interior provides ample housing space for mechanics, gasoline, water and spare parts. Trans-oceanic planes will refuel and make repairs at the mid-ocean platform. Passengers and mail could also be transferred from one plane to another. By means of powerful searchlights and neon beacons, the platform will be visible to aviators even in the most foggy weather, and will offer a haven where they can repair until storms have abated. For shelter, the planes could be lowered into the interior of the platform, or suitable hangars could be arranged upon the upper deck.

The construction of the Thomas turbine which makes this mid-ocean landing stage possible is shown in the smaller illustrations. A vertical shaft is fixed in the center of a rigid frame which can be of steel or reinforced concrete. This shaft carries two rectangular frames whose horizontal arms are fastened to the shaft by means of sleeves. The vertical members of these rectangles are formed by tubes which can turn on their own centers. Each of these tubes carries a wing or sail which is free to turn in or outside of the frame. The extent of motion is limited by two springs, R and R_1. Both are attached to the lower sleeve of the main shaft, prolonged by two cables which pass over two pulleys on the upper sleeve which carry them to the two extensions of a sort of lever arm, the latter fastened to the vertical tube which carries the sail or wing.

When the wing occupies position A, the impulse due to the current which may be wind or flowing water is at its maximum. The spring R is completely stretched while the spring R_1 is completely slacked. This position is brought about by the maximum tension of the spring R_1, so that the angle made by the sail and lever arm has a fixed value. At this instant, the opposite arm A_3 has a position sensibly parallel with the current. Each sail works through an arc of 270 degrees, so that there is only 90 degrees of useless rotation and, as the turbine carries at least two sails, forming an angle between them of 280 degrees, there is a constant force exerted, whatever the wind direction.

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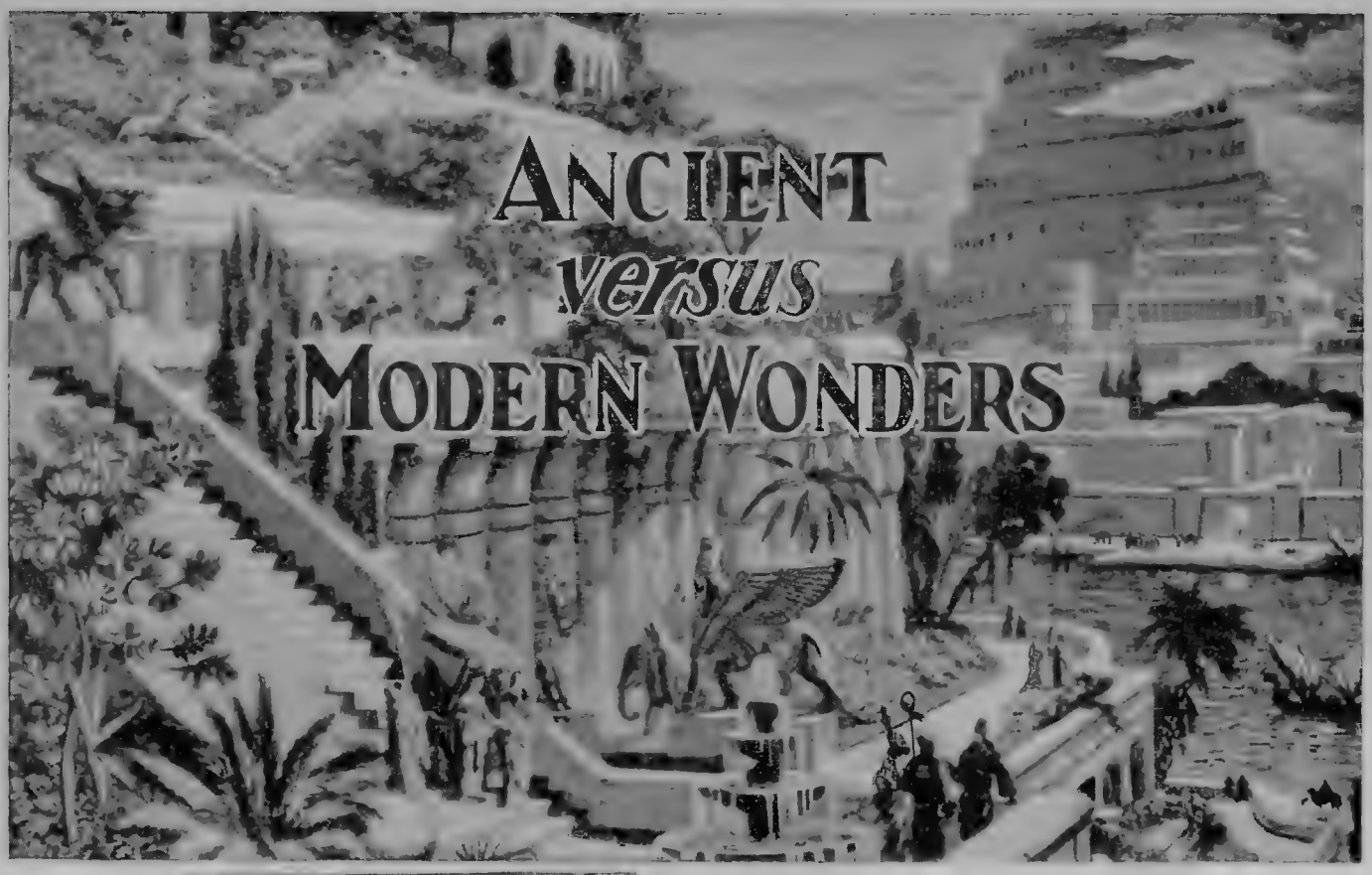
ANCIENT *versus* MODERN WONDERS



This illustration shows one of the seven wonders of the ancient world. Built according to tradition by King Nebuchadnezzar to please his homesick wife, Amytis, the beautiful hanging gardens of Babylon became one of the world's show places, and their reputation has been brought down through history. The Tower of Babel is seen at the right.

At the left the Gold and Ivory Monument, 60 feet high, known as the Statue of Zeus, in the Temple of Olympia.

Right—The Pharos Lighthouse erected by Ptolemy on the rocky island, Pharos, off the Mediterranean coast. The base of this lighthouse was 100 feet square.

Below—the Mausoleum of Halicarnassus, reconstructed by an artist from the best drawings and photographs available.

On these two pages are shown the artist's conceptions drawn from the best information or recognized drawings available, of the world's Seven Ancient Wonders.

Photos—
Ewing Galloway

SEVEN WONDERS OF THE WORLD

THERE are two lists of the seven wonders of the world, which differ from each other but slightly. The first is known as Antipater's list, which calls for the Walls of Babylon, the Statue of Zeus at Olympia, the Hanging Gardens at Babylon, the Colossus of Rhodes, the Pyramids of Egypt, the Mausoleum of Halicarnassus and the Temple of Artemis (Temple of Diana). The second list, illustrated here, combines the Walls and Hanging Gardens as one, and adds the Pharos of Alexandria.

AS mentioned in the blurb on the left-hand side of this page, two lists of the seven wonders of the world are recognized. The first, known as Antipater's list, differs but slightly from the second, in that it combines the Walls and the Hanging Gardens of Babylon under one classification and adds the Pharos of Alexandria as the seventh wonder. For purposes of illustration, the best available data has been used by the artist for the foundation of the drawings which appear on this page. This data was culled from books, sketches, and written descriptions made by those who are considered authorities on these subjects of antiquity.

At first it was thought advisable to limit the modern wonders to only seven, but that was

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By
JOSEPH H. KRAUS

impossible. The list grew, until there were so many topics included that it would have taken this entire magazine to illustrate the modern wonders, but that is getting a little ahead of the story.

By way of further description, we shall add a few lines about each of the seven wonders of the ancient world, and then compare them, indirectly, with the wonders of the modern age by describing these.

Hanging Gardens and Walls of Babylon

ON these pages we have listed the seven ancient wonders. The first one indicated is the Hanging Gardens and the Walls of Babylon. According to tradition, these were built by King Nebuchadnezzar to please his home-sick wife, Amytis. Tradition further states that Amytis was from the hill country. The flat country around Babylon bored her, and apparently "got on her nerves." In order to please her, and to make her satisfied with the country of her adoption, the king had these elaborately terraced gardens constructed, to give her the "hill" effect. The terraces were built up to a height of 300 feet, and were beautifully planted with trees and flowers. Frequent fountains and dining halls were distributed through the gardens. Irrigation was accomplished by pumping water from the Euphrates River, seen in the background. On the other side of the Euphrates, if one will refer to the illustration, one will see the Tower of Babel.

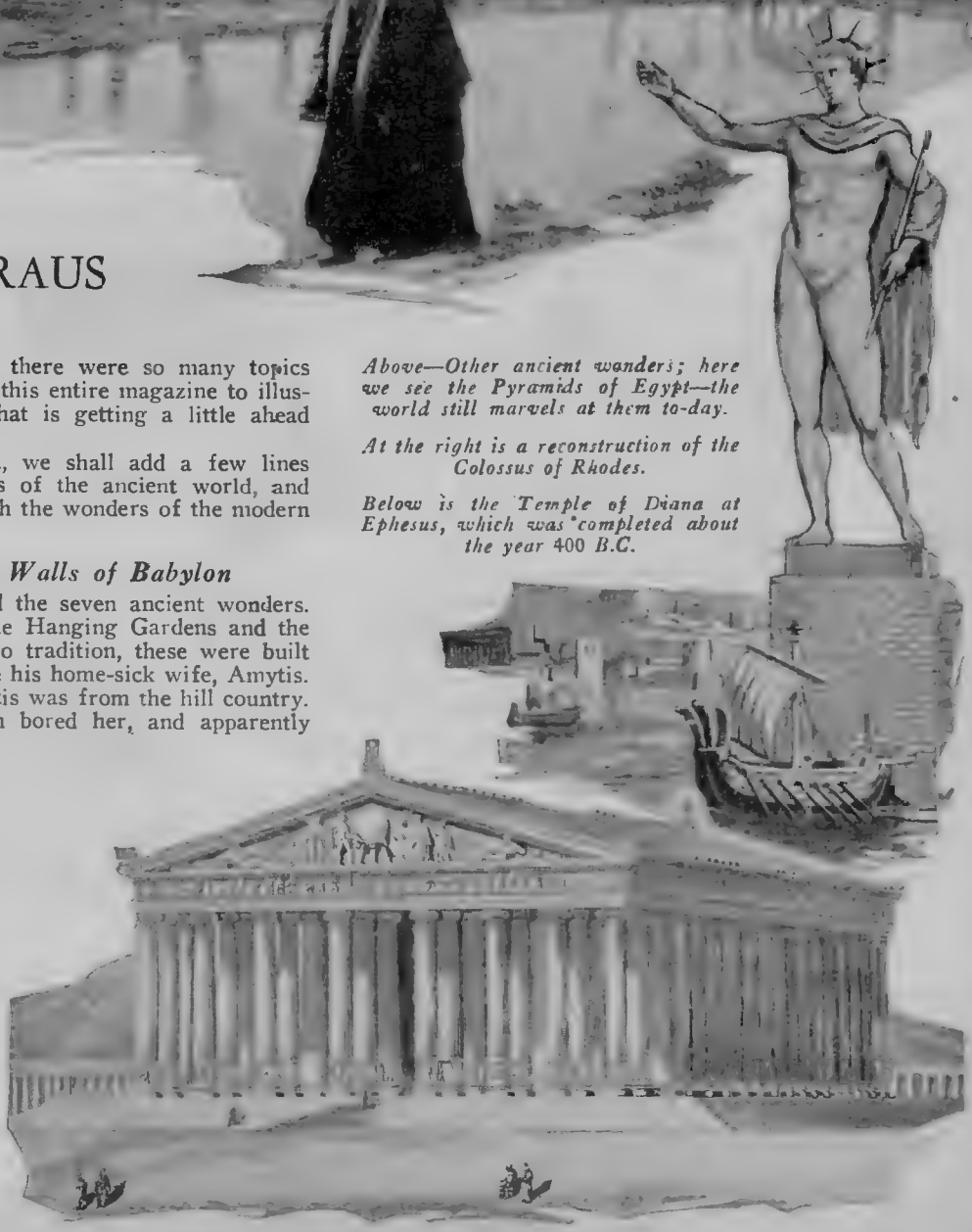
As we proceed with these

(*Continued on next page*)

Above—Other ancient wonders; here we see the Pyramids of Egypt—the world still marvels at them to-day.

At the right is a reconstruction of the Colossus of Rhodes.

Below is the Temple of Diana at Ephesus, which was completed about the year 400 B.C.



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ANCIENT *versus* MODERN WONDERS

We surely must include modern engineering among the modern wonders. Here is a view of the skyline of New York. It shows also the advance of modern transportation in the form of both a plane and dirigible.

Radium—one of the world's modern wonders. The photograph below shows the apparatus employed for securing emanations for medical treatments.
Photo—U. S. Radium Corp.

The modern horseless carriage, a high-powered automobile has brought us in closer contact with our country.
Photo—Rolls-Royce Co.

Modern transportation in the form of a large steamship is a modern wonder.
E. W. Photo.

On these two pages, some of the modern wonders are illustrated. There are many others too numerous to mention. The various branches of electricity such as lighting and other numerous applications, and the many sciences are not recorded.
Photo—Ewing Galloway.

Modern rail transportation. This shows a tug-of-war between two steam locomotives and an electric engine. Electricity won. ⟹
Photo—General Electric Co.

A modern hydro-electric power plant. The generators can be seen extending down the building nearly as far as the eye can follow.
General Electric Co. Photo.

X-rays are included in this general grouping. This photograph shows one of the largest X-ray apparatus ever built.
General Electric Co. Photo. ⟹

seven wonders, we will find that the majority of them were considered such because of architectural beauty. In this modern age of science, architecture does not hold the same universal appeal which it did then, yet there is no doubt but that any one of our skyscrapers would by far surpass the most marvelous production of the ancient days.

The Statue of Zeus

MYTHOLOGY tells us that Zeus surveyed the doings of Gods and men. When wrathful, he would hurl his thunderbolts. He was supposed to have had his throne on the summit of

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We cannot conceive of a group of modern wonders without including therein a mention of the Panama Canal. Were it not for sanitary engineering, this canal would probably never have been built.

Photo—Ewing Galloway.

At the left, the modern wireless transmission plant. Radio is a relatively new art, and perhaps aside from television, it is one of our most recent of sciences. In a short time it has attained world-wide popularity.

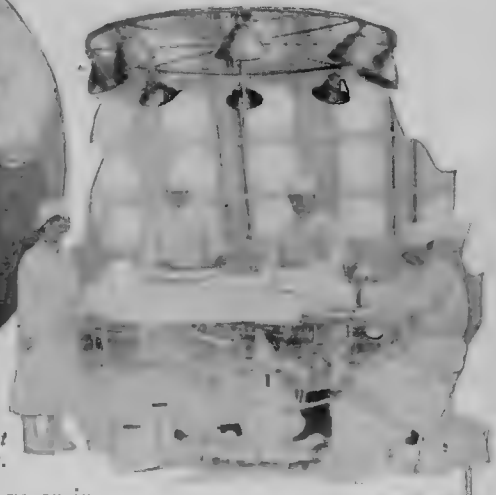
Photo—Ewing Galloway.

Television—This science is in its infancy in so far as its radio connection is concerned. We dare say that within a few years we will be able to see and talk to anyone who has a pocket radio transmitter and receiver.

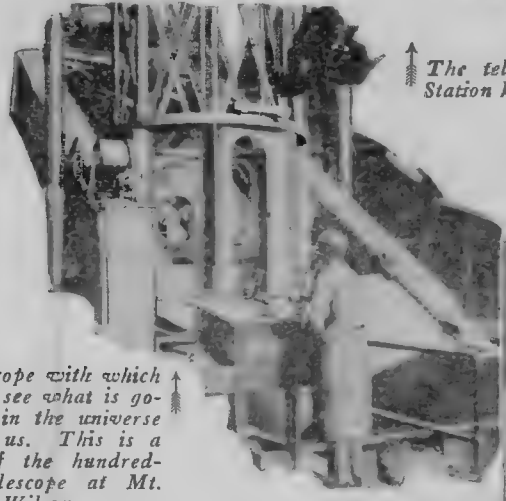
Mt. Olympus. The artist has reconstructed this Statue of Zeus which was 60 feet high in the original. It was made of gold and ivory, and was executed by the Sculptor Phidias, considered to be the supreme among ancient sculptors. Zeus was the Jupiter of Greek mythology. He was the King of Heaven and had complete sovereignty over countries and men.

(*Continued on page* 84)

The television apparatus installed at Station WRNY. This shows the receiver.



Diagonally at the right we have an interior view in a floating hospital. What would modern surgery be (another modern wonder) without the aid of anesthesia.



A telescope with which we can see what is going on in the universe around us. This is a view of the hundred-inch telescope at Mt. Wilson.

Here is a television transmitter located at Station WRNY in New York. The person sitting at the transmitter is having his living "moving" image broadcast by means of electrical impulses, which are unscrambled at the receiving end.

Should we not include modern chemistry, the microscope, and bacteriology among the modern wonders? This photo shows a well-equipped laboratory.

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The author of the present article is a prominent aeronautical expert and for over twenty years has helped to make aviation history. Mr. Post is the editor of the work—"Aero Mechanics."

GLIDERS

By

AUGUSTUS POST

Motorless Planes Provide Good Outdoor Sport and Show the Principles of Flight

WHEN Captain Thomas Scott Baldwin—"Uncle Tom," as he was called—was demonstrating the parachute on his trip around the world, he told me that he was invited to make a balloon ascension and "cutaway" parachute descent during the elaborate ceremonies attending the coming of age of the son of the ruler of Siam. The demonstration was given before the astonished multitudes, who had never seen anything like it in their lives before. But the tutors of the young prince brought one of their sacred books containing a long and circumstantial account of men who jumped from a high bamboo tower, descending to the ground by the aid of large umbrella-like contrivances with long handles of bamboo, which were crooked in such a way that they could be hooked into the strong sash-belts that they wore. These records were very old, and told of the early ceremonies attending the coming of age of the ruler of that day; so that these may be among the earliest records of actual gliding flight.

Glider Flying Now Important

WHILE it is the oldest form of dynamic flight, the passage of time has brought it about that gliding has become the newest method of air-navigation. Flight without motors appealed particularly to the Germans who were prohibited after the war from building power-machines. They have carried this type of construction to a high degree of efficiency and the skill used in its manipulation to an extraordinary degree of development. Indeed, the present-day glider, as it appears in such contests as the Rhoen Valley meet, represents the acme of delicacy and finesse both in design, building and piloting.

The study of gliding and soaring and the construction of machines in which this may be accomplished, are both based on observations of the flight of birds. F. H. Hentzen, a German pioneer in this development, one of the most skilful pilots of motorless planes, and holder of many records, has classified the various kinds of bird flight as the "rowing" flight, the "shaking" flight (which is the same as the "rowing" but stationary); the "finch's" flight (which again is the same as the "rowing" but interrupted by stretches of forward precipitation); the "rowing" flight interrupted by stretches of "gliding," and the "sailing" flight. Occasionally the same bird will use all these methods of flying in quick succession. A careful study of birds in flight has served as a basis for aircraft development.

Fig. 3—The above photograph shows the glider just after it has been released by the assistants. When the pilot feels the plane pulling upward, he signals to be let free.

Fig. 2—The above photograph shows a glider being launched. Two assistants help in this operation.

Fig. 1—The author, Mr. Augustus Post, is shown above.

Why a Glider Flies

HENTZEN goes on to say: "A bird glides with outspread wings and merely steers its course in a forward and downward line, according to the law of gravity; *but since this sinking takes place in an upward air-current, it lifts the bird constantly, in the same proportion in which it would sink without this current; that is, it remains at the same height, retaining at the same time the speed of its forward motion.* This is one kind of sailing flight. If a bird sinks at a less speed than the air current lifts it, the flight takes an upward line corresponding to the difference between the two speeds. If this is reversed the bird slowly sinks lower. This process could be compared with a man going down an upward moving escalator. If he walks down faster than the escalator rises, he will eventually reach the bottom; if the two speeds are identical, he will remain at the same height; if his downward speed is less than the escalator's upward speed, he will be slowly carried upward. Birds sail in this manner upon air currents." Man has now become mighty interested in learning just how the bird flies.

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Fig. 4—The glider is shown above, just about to leave the ground. In more advanced models of gliders the pilot sits in the fuselage and controls the plane with a joy-stick, as is done in present-day airplanes.

Pilot of Glider Learns About Air Currents

THE pilot of a motorless plane must understand air currents and the weather conditions that influence them, also the conditions of the ground that produce the deflection of the air currents and cause them to have an upward trend. Wind currents are often affected by cloud formations; the ablest pilots cannot only navigate from one hillcrest current to another across intervening valleys, but can even gain altitude by using wind currents engendered by cloud formations. Above the clouds the pilot can see "chimneys," or rising currents of air that move the mist, and thus make the currents visible. The highest records have gone over 2,500 feet; pilots have remained fifteen hours and a half in the air, and have covered more than forty miles measured from the point of starting, while much greater distances have been covered in the process of circuitous flights in many cases.

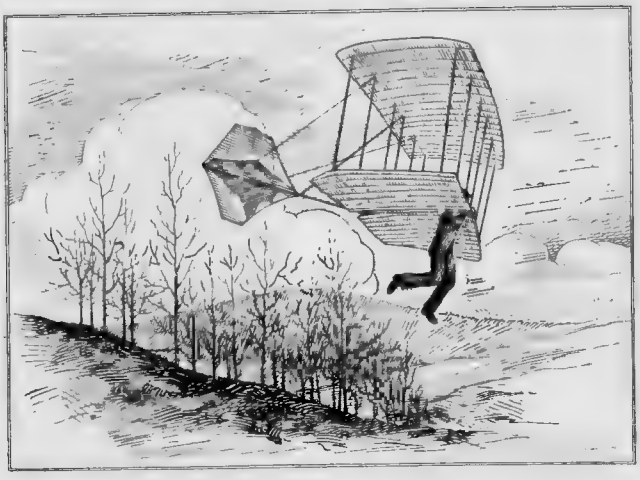

Fig. 5—The glider has left the ground and is starting on its soaring flight. The Wrights' early gliding experiments led to the first power-driven machine.

Cost of Gliders

A GOOD example of the degree to which the modern soaring plane has been developed is afforded by the "Mecklenburg," lately built at the workshops of the Mecklenburg Aero Club, Rostock, Germany. This is a two-seater; at the time of the Rhoen Valley competitions it made 133 flights without a mishap, one of the flights being over an hour. Others are built at Darmstadt and at Cassel, cities which have given their names to types of machines already famous. They cost in the neighborhood of a thousand dollars apiece and have a wingspread of sixty-five feet, but weigh little more than two hundred pounds. They are built of plywood and have an enclosed fuselage.

Training gliders are less expensive and can be built to be sold for about five hundred dollars. The materials, however, can be purchased in the neighborhood of a hundred dollars. The dangers of learning to operate them are not great, as there is no heavy motor, and in a wind of ten or fifteen miles an hour blowing up the slope of a hill, the glider does not move very fast over the ground.

Selecting a Practice Ground

IN selecting a practice ground, it is necessary to find a hill that slopes in as many directions as possible, so as to take advantage of winds blowing from various points of the compass. Kill Devil Hill, North Carolina, where the Wrights conducted those early experiments in gliding that led up to the first power-driven machine, was admirably situated for these experiments, as flights could be made from its cone-like summit in any direction. For soaring, of course, a long ridge or cliff, such as was found at Corn Hill, on Cape Cod, was more suitable, as Hasselbach proved when he made his record there on July 29, 1928, of four hours and five minutes. These demonstrations have stirred up a strong interest in this country and have brought about the organization of many glider clubs, included in the National Glider Association, founded by Edward S. Evans, of Detroit. Among the foremost of these clubs are those at the University of Michigan, Ann Arbor, and at San Francisco. One of the most promising lines of development for this type of air navigation in this country is in connection with the colleges. In Germany, the students form the largest class of those concerned with gliding; there are more than a hundred clubs, with some ten thousand members. They have three grades of pilots; the first must qualify by a glide of at least thirty seconds duration; the second, using a much heavier machine, must be able to make a right and left turn with it, and remain in the air for one minute. The third grade calls for a flight of five minutes above the starting point in soaring flight. Many students are able to qualify for the third grade in a month.

How Gliders Are Launched

GLIDERS are launched in the air by means of a long rubber cable, which is attached by a ring to a hook fastened on the nose of the glider. The ground crew stretch this cable, running ahead of the machine, while it is held by others in the rear; upon the giving of a signal by the pilot, those in the back let go and the machine is catapulted out like a stone from a slingshot. The cord automatically drops off, and the pilot is free to take advantage of the currents.

With a rising generation of air-minded boys, America is bound to become a leader in this most fascinating of all outdoor sports. As the German transport companies require their pilots to be expert at soaring, no doubt American transport pilots will in time be required to prove their proficiency in the manipulation of a motorless plane, so that they will be not only in a position to take advantage of visible air currents but will be experts in making safe landings if their motors should fail.

We can hardly conceive of a greater sport than that of gliding, and at the same time there is hardly another sport which contains so many thrills, and which can be pursued at so slight a cost. A future article will tell how to build a glider.

Fig. 6—When landing, the wings are tilted sharply, so as to offer a greater resistance to the air, as shown above.

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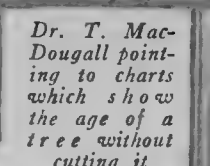
Scientific

Many of these "genuine mermaids" are exhibited in the orient. Actually, they are synthetic, being built up of a mumified head and body of a monkey, deftly fitted to the dried covering of a fish. These mermaids bring a very high price.

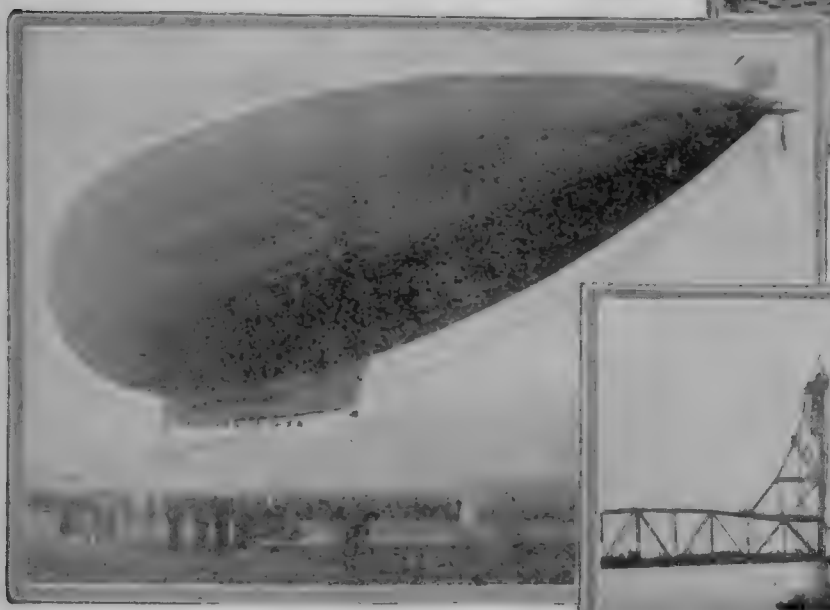
Extra wheel with a radius two inches less than the regular wheel, allow a car to drive ahead safely in spite of flat tires. There is no injury to the pneumatic tire. Extra wheel can act as a jack by driving up on a block.

X-rayed tree-sections tell its age.



Dr. T. MacDougall pointing to charts which show the age of a tree without cutting it down.

Prof. E. F. Chaffee, of Harvard University, with his system of recording the act of vision electrically, and which will greatly aid in the diagnosis of eye conditions. Records are obtained via thread-like electrodes applied to the eye.



The all-metal dirigible gets its initial airing. Constructional details of this vessel have already appeared. Right: The span of a bridge being towed into place at high tide. As tide recedes, it is locked in position.

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Progress

A high-powered racer with which it is expected to smash the world speed records.

This drawing and the one showing the side view of the automobile reveal Major H. O. D. Segrave's new car, equipped with a 900 horse-power Napier engine. On March 11, this car established a record of 231.36 miles per hour.

The motor ski shown above was hailed with delight by enthusiasts of that sport in Switzerland. The engine is attached to a ski which the user straddles

A new system for controlling traffic in which light from a lamp directed to a selenium cell located in the road, is intercepted by a vehicle, which causes the lights to change.

The photograph below shows a miniature railway being controlled by the voice. A single word causes it to go forward. Any combination of two words stops the train, and three words, makes it run backward.

A South American inventor has constructed the device shown at the left, by the aid of which he is able to walk much faster and further. It is claimed that an oscillating weight does the work.

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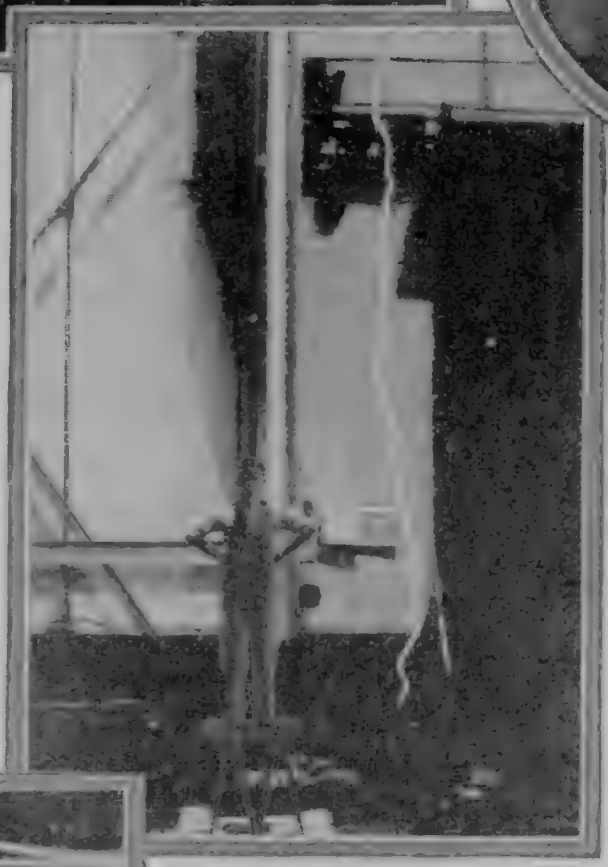
5,000,000 Volt Man-Made Lightning

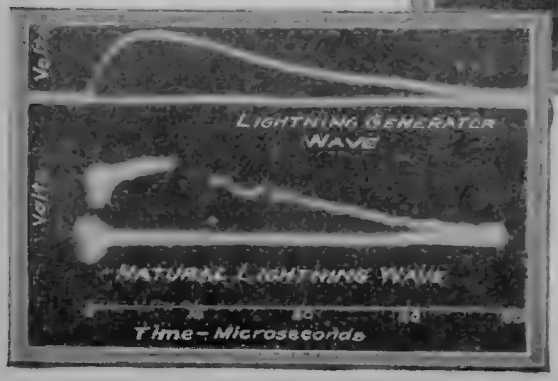
Electrical Engineers Develop New Method for Creating High Voltage Discharges in the Laboratory

Above is a view of the interior of the high voltage laboratory showing three of the one and one-quarter million volt units connected in series. Some idea of their size can be obtained by comparing with the man in the foreground.

IN the Pittsfield laboratory of the General Electric Company, an artificial lightning discharge of 5,000,000 volts has been developed by Mr. F. W. Peek, Jr. The many fields in which the high voltage will be used experimentally have yet to be determined, but it will be employed in the study of natural lightning, its effects on electrical transmission apparatus and means of protecting this apparatus from damage by lightning. The increased voltage will make it possible for engineers to closely approximate the effects of natural lightning.



Above is a 5,000,000-volt artificial lightning discharge. This is a double exposure, with the man photographed first and then the 16 ft. spark.



At the left is a duplication of the natural lightning record obtained by means of the lightning generator described here. The extraneous oscillations were omitted in the case of the generated wave.

Four One and One-Quarter Million Volt Generators Used

FOR producing the high voltage discharge four one and one-quarter million volt generators are connected in series, so that their output is added together at the proper instant. Alternating current is supplied directly to each generator and on the crest of the wave, when

Above is a photograph of Mr. F. W. Peek, Jr., of the General Electric Co.

each unit is fully charged, gap spark-overs occur, connecting the generators in series and permitting maximum discharge. Resistances between the units permit the 60-cycle current to flow and charge the generators, but they will not permit the flow of high impulse current, thereby necessitating the spark discharge of 5,000,000 volts in order to discharge the units. By varying the resistances, condensers and inductance, the characteristics of the wave form can be changed. Waves varying in duration from a few millionths of a second, to a thousandth of a second, have been used in experiments. By using more units in series, it is expected that even higher voltages can be produced.

10,000,000 *Volts Recorded*

ALTHOUGH the voltage produced directly is 5,000,000 volts, the maximum voltage measured is now about 10,000,000 volts, the result of the doubling of the high voltage impulses at the ends of the transmission line. An analogy may be drawn by comparing the action to a water wave, which upon striking a

(*Continued on page* 88)

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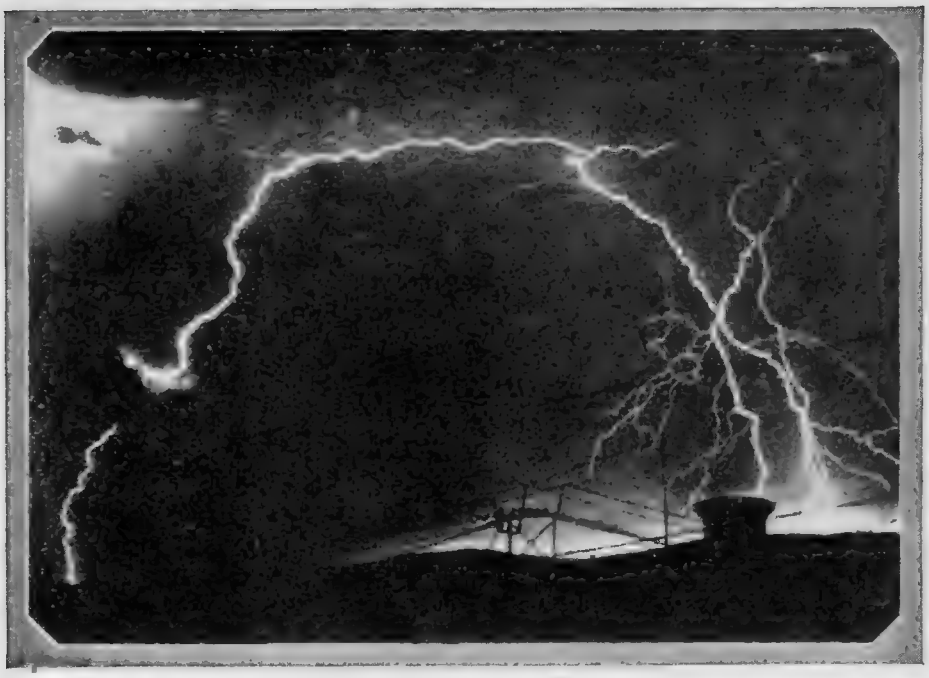


Cathode Ray Oscillograph and High Frequency Oscillator Used for Scientific Study of Lightning Discharges Such as These.

Lightning Writes Own Record

By CHARLES E. KRAUSE

An Exact Record of a Lightning Surge Made by Norinder Oscillograph. Klydonographs Record Maximum Shock.

VALUABLE information relating to probable improvements in the protection of apparatus connected to electric power systems against damage from lightning disturbances will result from a scientific study of lightning surges on transmission lines. Such an investigation is now being conducted by the Westinghouse Electric and Manufacturing Company in Chicago and in the mountains of Tennessee with the aid of the Norinder cathode ray oscillograph.

Cathode Ray Oscillograph

UNTIL recent years no apparatus had been devised capable of photographically recording the complete story of lightning surges, since the fastest mechanisms all involved inertia and were therefore too slow to respond to rapidly changing quantities. The cathode ray oscillograph does not have this undesirable feature, since the recording element is merely a stream of minute particles of matter called electrons which experience magnetic or electro-static deflections proportional to the transient voltage before impinging upon a photographic plate where they register an impression of their path. However, for the study of lightning surges on transmission lines due to induced charges or direct strokes of lightning, the ordinary cathode ray oscillograph has presented the inherent difficulty of not getting into operation at the start of the lightning disturbance. This delay is not present in the Norinder* cathode ray oscillograph.

Timing the Surges

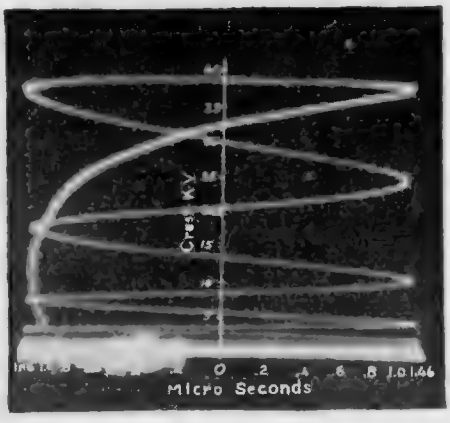
A HIGH frequency oscillator has been designed to act as a timing device for the cathode ray oscillograph, thus permitting great accuracy in the study of wave shape, rate of change in voltage and duration of the transient caused by a discharging cloud. The oscillator shown in the photographs is particularly adapted for such an investigation, since it may be used for supplying alternating currents or potentials ranging in frequencies from about 20,000 to 400,000 cycles per second.

The use of the oscillator as a timing device can best be explained by referring to the illustration shown here, which is a schematic diagram of a cathode ray oscillograph equipped with two pairs of deflecting plates. Suppose a constant stream of electrons, known as a cathode ray, originates at the cathode "c" of the oscillograph. After passing through a pin hole in the anode "a," the electrons pass between two pairs of plates arranged at right angles to each other, where they experience deflections by the electrostatic fields produced by the charged plates. First suppose plates A are connected to the oscillator supply, with the pair B short circuited, for the purpose of eliminating disturbances. A recurring straight line will then be traced on the photographic plate, "D," once each half cycle of the oscillating field, which for a frequency of 400,000 cycles would mean 800,000 retraces per second across the film. If the short circuit connection between plates B is now removed and a lightning surge is impressed across them, a curve will be traced on the film similar to those shown here.

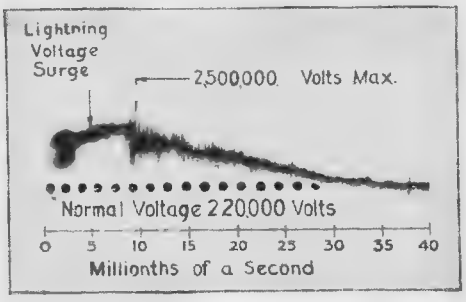
The Oscillogram

AN involved oscillogram of an artificial lightning surge and its reflections which were propagated over a transmission line approximately 5 miles long may be seen. Upon reaching the oscillograph

(*Continued on page* 66)



Above is an oscillogram which shows the changes of an artificial lightning surge with time measured in micro-seconds. The record was made in 32 millionths of a second, by a beam of cathode rays.



The nature of a lightning stroke on transmission wires is well illustrated above. Maximum voltage is shown.

*H. Norinder, Lightning Surges, Journal of Franklin Institute, June 1923. "Electric Thunderstorm Field Researches," Electrical World, February 2, 1924.

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Above is a special trench perfected by Dr. Weaver for studying root habits.

New Study *of* Plant Roots

By
JAMES R. LOWELL

Delving into Bosom of Mother Earth Reveals Surprising Facts

THEY said there were no more frontiers in the United States, but Dr. John E. Weaver, professor of plant ecology at the University of Nebraska, found one that was practically unexplored and of vast extent. This modern pioneer didn't travel east or west, north or south; instead, he delved into the bosom of mother earth.

The scientist has a way of applying his trained eye and hand to commonplace subjects, which the layman holds in the contempt bred by familiarity, and bringing to light an array of new and vital facts before the very eyes of an astonished world which scratches its head and says, "Why didn't I think of that before?"

Fourteen years ago Doctor Weaver elected to explore that seemingly familiar realm, the lowly earth, with a view to seeing at first hand just how the root systems of plants behave and why. One would think that so accessible a subject would have been thoroughly exhausted by botanical specialists in view of the length of time in which crop production has been the basic industry of civilization; however, there has been a comparative dearth of research work on root systems, while libraries have been filled with volumes taking up from every conceivable angle the aerial growth of plants.

Cultural practices in the production of crops have been largely empirical as a consequence of the lack of knowledge of root habits. Crops are sown, cultivated, pruned and reaped in accordance with time-honored customs and with little or no regard as to the harmful effects upon the roots that may ensue from certain types of cultivation, pruning and transplanting.

Doctor Weaver's investigations upset many of the established beliefs held by crop growers. The farmer who gives vent to his ambition by frequently and deeply cultivating his corn, in keeping with the tradition handed down by his fathers, will be shocked to learn that his energy has been worse than wasted. "Suckering" or removing the tillers from the base of the corn-plant stem also results in a decreased yield.

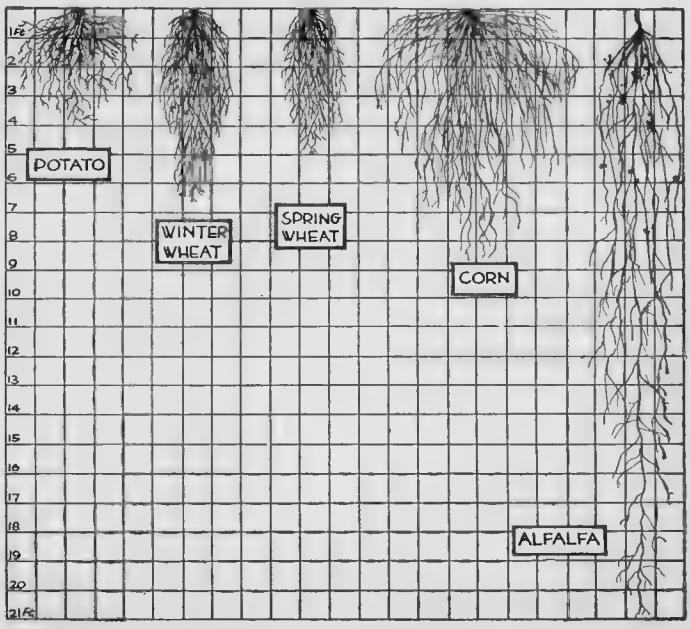
The reason that deep and frequent cultivation of corn is harmful is because of the resultant disturbance of the root system. Cultivation of corn and other crops that have extensive systems of lateral roots, lying close to the soil surface, should be done early in the season for the purpose of weed eradication and the prevention of a soil crust, and then no deeper than is absolutely required to get out the weeds, the pioneer investigator finds. Cultivation to the depth of an inch will result in a larger crop yield than four-inch cultivation.

One of the most important discoveries made by Doctor Weaver was that root systems are not chiefly confined to the surface foot of soil as was formerly believed in botanical circles, but are active in nutrient and water absorption up to a working depth of six to eight feet in most cultivated crops including our common garden vegetables. The roots of many other crops are active from a depth of ten to twenty feet. The roots which run laterally from the stem of the cucurbits or vine crops may extend farther than twenty feet each way, accounting for the failure of such plants to thrive when planted closely together.

Observations were made last year on muskmelons and watermelons which had a lateral spread of roots amounting to more than forty feet, and the roots of the morning-glory found on the Eastern Colorado plains were found to be well developed at a depth of twenty-two feet. Doctor Weaver estimated that the roots went down twice that distance. This morning-glory has a tap-root closely resembling the sweet potato (a member of the morning-glory family) and which is so large that it is used for fence posts on the prairie ranches and farms.

A corn plant is found to send its roots nine feet downward into the soil, while the spread of the lateral roots is nearly seven feet on an average. The (*Continued on page 73*)

Thechart below shows the comparative extent of root systems of five of the more common field crops. The close proximity of many of the lateral roots of corn to the soil surface shows why crop cultivation is harmful to that plant.



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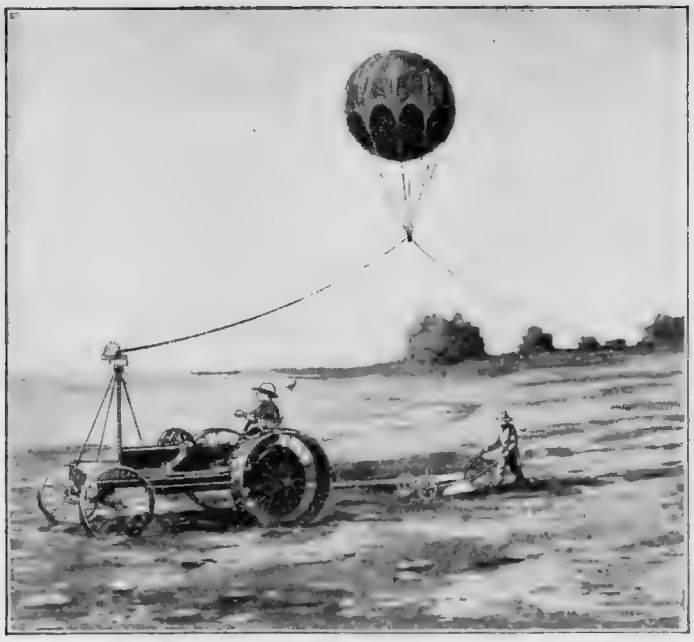
Earlier Planting and Better Crop Yield



The illustration at the left shows an electric tractor which draws its current from a power line attached to a captive balloon. The lifting power of the balloon depends upon the weight of the cable.

Electricity Aids Farming

THE rational development of the electrification of rural districts depends in a great part on proper utilization of electric power. Electric farm cultivation, a great consumer of current, away from the peak, that is to say the time when the central stations are producing more power than is required, becomes an important factor in a good distribution of the use of current. There are three solutions used for doing farm work. The plow may be drawn directly by a storage battery tractor; the tractor may receive its energy by an easily handled trolley; or else finally the plow is drawn by steel cables wound up on drum-windlasses which are operated by electricity, the drums being located at the edge of a field.

In short, the problem to be solved is the following: to carry electric power as required to the tractor without impairing its freedom of movement.

Here is how three Italian engineers, the brothers Mazza and Bolledi, have solved the problem by an arrangement as ingenious as original.

Electric current is taken from the line nearest to the field of work. It is generally three-phase current with high potential. First of all, its potential is stepped down, and it may be converted into direct current. The power is then carried to the motor on the tractor by means of a cable. This instead of being wound on drum-windlasses, is suspended by a captive balloon. A rotary contact on the summit of a little mast on the tractor gives it all necessary liberty of movement. The balloon of a capacity depending on the weight to be supported, is attached to the middle of the cable. There is an additional steel mooring cable.

To resist the action of the wind, the balloon should have an ascentional power over and above what is necessary for carrying the cable.

This solution, at once practical and economical, for supporting cables of a power circuit, makes it possible to establish in short order a complete plant with a minimum of material.

Plowing and harrowing the field preliminary to planting the seeds is rather slow and especially during rainy weather the work is tedious and tiring. Instead of losing time, the modern farmer does not wait until the day to do his plowing, but starts in as soon as the ground is dry enough even though night has fallen. By means of headlights attached to the tractor he is enabled to save time by working the ground at night. Tractors carrying automobile headlights are now seen frequently in rural sections where enterprising farmers are working during the night. The result is a better crop yield and earlier planting made possible by electricity. Not only is this medium employed for night farming, but also for supplying artificial sunlight to hasten the growth of plants by forcing them to bloom during the winter in hot houses. Electricity has emancipated the farmer and made his work less irksome, giving him spare time for amusement.

Electric Tractor and Night Cultivation

ELECTRIC power now supplying the rural districts is responsible for better farming. Fields can be cultivated at night and even planted by using electric lights for illumination. The work of plowing, which is usually slow during wet weather, is in many cases now accomplished at night with tractors carrying automobile headlights. The plow may be drawn directly by a storage battery tractor, or by an electrically operated drum windlass. A recent development has been the carrying of electric power from the line to the tractor without hindering its movement.

The above photograph shows a farmer "discing" his field by night with the aid of powerful lights placed on the tractor. Tractors carrying automobile headlights are now a common rural sight.

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Training for Winter Sports in Palaces Containing Artificial Snow

A GREAT future lies before the invention of artificial snow, due to the Englishman Ayscough, by which training in ski sport can be admirably carried out, quite independent of all changes in the weather, giving a true inspiration to it and an introduction to the beginning of the art of ski racing, and not only on the present natural ski tracks to which it has hitherto been confined. Artificial coasting tracks give a sensation of true value for the feeling and development of ski sport, a true milestone, as is shown for example on the well-known films of skiing, "Wonders of the Snow-Shoe," "Fox Hunting in the Engadine," and many others.

Artificial snow is not expected to force into a background the natural panorama of the mountains, with its ski tracks and fashionable winter sports and winter palaces, something the greatest optimist would not expect, because nature can never be replaced. The undoubted value which lies in the artificial ski tracks built in snow palaces lies in the fact that the ski clubs will have new interests in these artificial courses, and even those who already are using the regular tracks must agree that on the artificial snow courses the ability and instinctive skill, already learned on real snow, can be increased and improved.

Here is a photograph of an interesting snow-shoe review taken in an indoor artificial snow palace in Germany. The artificial snow is a salt which does not melt, yet which forms a remarkable snow-like carpet.

About two years ago the first exercises were carried out in the Haymarket in London, with the artificial snow invented by Ayscough, where at the entrance of a little lane there was a small sign with the inscription, "This is the way to the London Ski School," which directed one to the "office," whch was situated in a cellar. As soon as you entered into the vestibule, you were surprised by a white snow-like layer covering the (*Continued on page* 83)

Artificial Snow *for* Indoor Winter Amusement Palaces

If you would learn how to use skiis, how to handle a toboggan properly, and yet be protected from all of the elements, a school in Berlin, Germany offers an excellent opportunity. A blanket of artificial snow covers the interior of the runway and this snow gives all of the characteristics of real snow, yet is perpetual. Sprinkling with water restores it to its former crystalline state, in event that a high temperature should reduce it to a powder. The artificial snow is a salt which will not melt.

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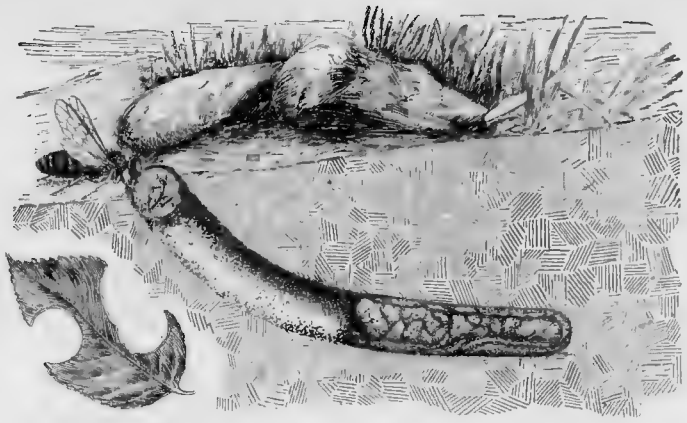


The leaf-cutting bee, Megachile, excavates a tunnel and lines it with pieces of a leaf cut in an oval shape and blocked into cells with round discs. The nest resembles a set of cars with individual cells cut from rose leaves.

Numerous Insects Build Beds for Their Young According to the Most Up-To-Date Mathematical Formulae. The Principle Which Each Uses is Described Here

Insect Cradle Builders

By DR. ERNEST BADE

Artistic Structures Based On Scientific Principles Protect the Young and Defenseless

MATHEMATICS is not only the science of numbers but also of space, and its technical use is found in practical geometry and a part of its application applies to construction and building. A mathematical proof cannot be doubted, it is an unassailable truth.

When the structures of certain insects are considered from this point of view some interesting conclusions

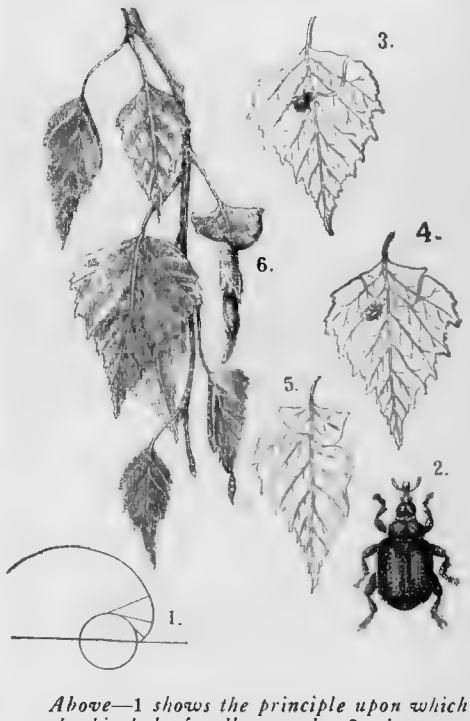
An arch is built by the tiny caterpillar Tortrix Forskaleana. This small insect just spins a number of leaves together in the form of an arch for its cradle in which it passes the larval stage.

may be drawn since a number of the insects build the cradles for their young according to the most up-to-date mathematical formulae. The fully developed and mature insect has only a short span of life. In the majority of cases the children never see their parents for the adults die before the young make their appearance. The parents can do no more for their children than to see that the eggs are placed in the most favorable place, both in regard to protection and food supply.

The worm of the leaf wasp, Pamphilius Inanitus, builds its own cradle in the form of leaf cuttings wound spirally around its body.

The Leaf-Rollers

CERTAIN weevils, belonging to the group of leaf-rollers, are real scientists, building their cradles according to mathematical formulae. They make cone shaped receptacles from leaves for the protection of their eggs. Some use a number of leaves,



Above—1 shows the principle upon which the birch leaf roller works, 2, the snout beetle, 3 and 4, the first and second cuts, 5, leaf cut ready to be rolled, 6, the appearance of the rolled leaf.

others only one leaf. Such tightly rolled, cones, made of leaves, may be observed on birch trees, beach trees and grape vines.

The female of the birch leaf roller or snout beetle (*Rhynchites betulae*) proceeds to work from the edge of the leaf near the petiol and gnaws a curved S-shaped cut to the main vein of the leaf. The main vein is then slightly notched. This reduces the flow of sap to the leaf. The other side of the leaf is also gnawed in an inclined S-shaped cut. Then, with the upper side (*Continued on page* 92)

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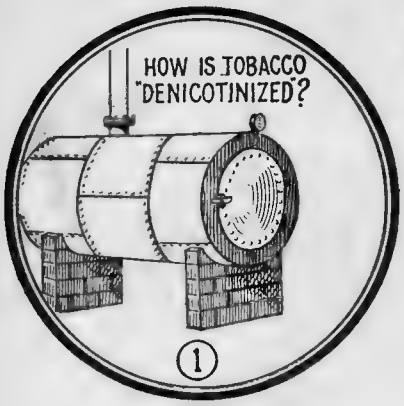
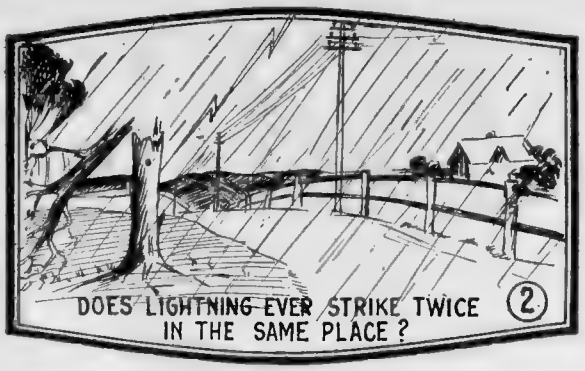
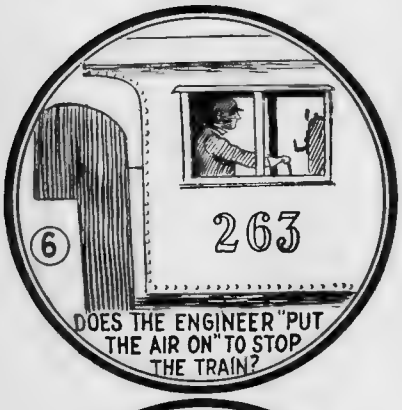


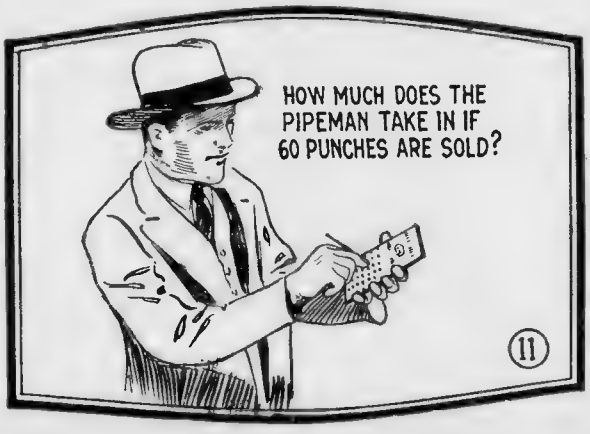


Science Oddities

By RAYMOND B. WAILES

HOW is tobacco "denicotinized"? Fig. 1, tobacco is usually "denicotinized" by sweating it with steam in a vacuum chamber. Recent analyses of samples of this tobacco show that the nicotine is never more than partially and sometimes not removed at all. Fig. 2, lightning may strike the same place many times. One stroke does not make an object lightning-proof. Fig. 3, a cork leg is not really made of cork but is made of wood and is named after its inventor, Dr. Cork. The artificial leg has borne his name ever since. Fig. 4, the ruffed grouse grows hair feathers on his toes in winter to serve as snowshoes, enabling him to walk on the snow without sinking. Fig. 5, yes, sea water can freeze. The freezing point is usually four degrees below that of fresh water. To stop a train, as in Fig. 6, the engineer takes off the air, thus applying the brakes. When a train is moving, the air is on all the time and holds the brake shoe away from the wheels. Fig. 7, the layer of air between two shirts keeps the heat of the body from going out into the cold air, consequently two shirts are warmer than one double weight shirt of the same material and weave. Air is a good insulator of heat and cold. Fig.8, the nail will still be the same distance from the ground. The starting points of the lower limbs of a tree never grow upward. Fig. 9, steam is invisible. What is commonly called steam is condensed steam and consists of minute droplets of water in the air. Fig. 10, icebergs are the big pieces of ice which break off from the glaciers as they flow down and enter the sea. Fig. 11, sixty punches, first one, one cent, last one, sixty cents. Take half of the number of chances and multiply this number by the first chance added to the last chance. Thus, half of the number of chances is 30. The first chance added to the last chance is 61. Now, 30 x 61 is 1,830, which the pipeman gains. Fig. 12, sprinkle some copper chloride on your logs and greenish-blue flames will result.





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Left photo taken by pointing camera down at the subject; submitted by R. G. Manwiller.

The photo of the enlarged hand at the right was taken by Harvey E. Headley with a small box camera.

The distorted donkey was the result obtained when James W. Ramsey ventured close and took a head on view. Notice that the body appears exceptionally thin, and the head large, giving the effect of a circus monstrosity.

Distorted Perspectives

The deformed bicycle was the result obtained by Mr. Stratton.

The prize winner in the distorted perspective contest for March was Raquel Torres, who submitted the above.

Mr. Riser caught this young woman in the act of walking away from the camera.

The photograph of the enlarged foot at the left was taken by Ben Davis.

L. L. Dolinsky placed his camera close to the bather's face while the body was under water and the feet protruded, obtaining the above effect.

The photo at the right was taken by Bernice Mallson. The camera was pointed upward.

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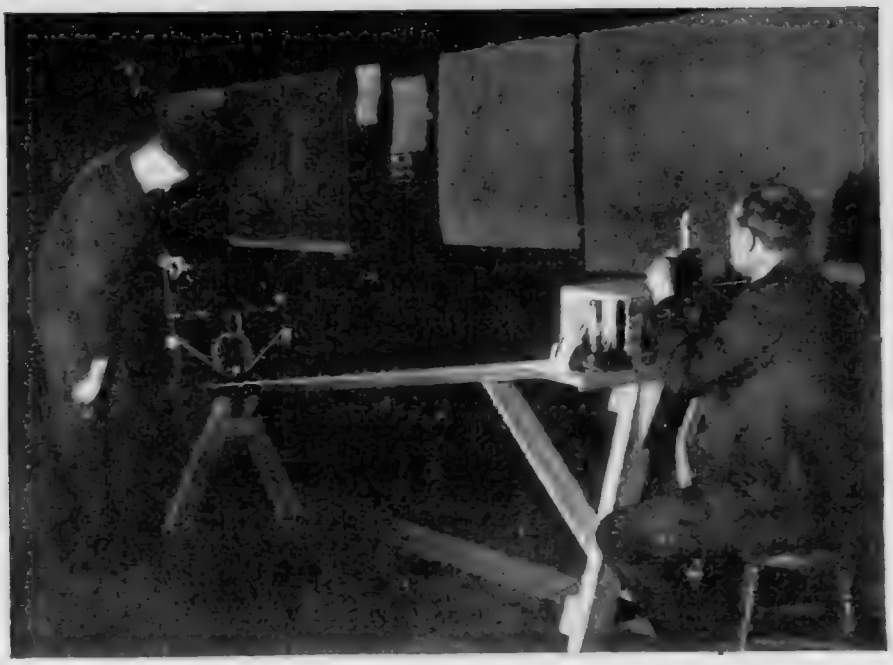
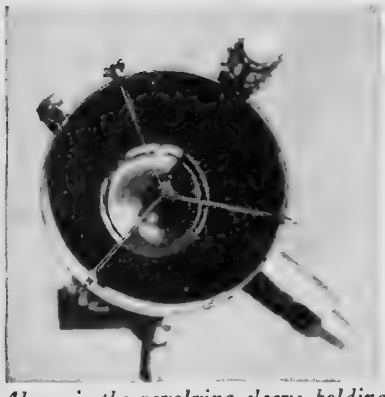


The above photograph shows telescope mirrors being tested in the laboratory of the Amateur Telescope Makers and Astronomers Society of Los Angeles, California.

Amateur Star Gazers and Those Anxious to Explore the Heavens Will Find This Constructional Article of Especial Interest

By
C. E. BARNS
*Member, American Astronomical Society, Variable Star Association, Astronomical Society of the Pacific, British Astronomical Association, Etc.**

How to Build a Reflecting Telescope



Above is the revolving sleeve holding the diagonal, flat, ocular-tube and finder for quick adjustment on either side of the pillar.

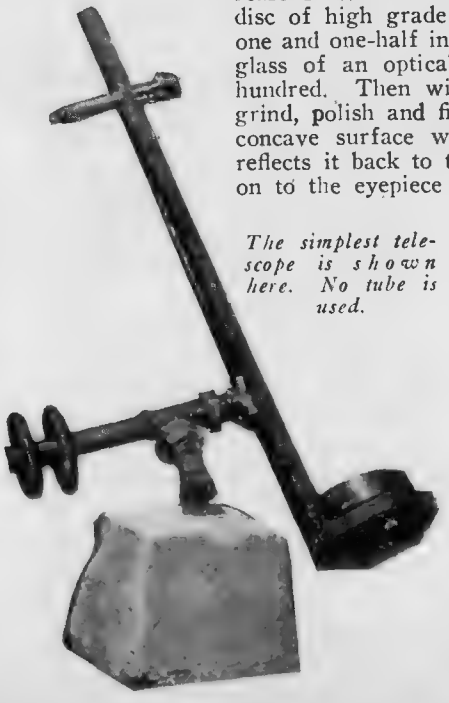
MORE than two thousand amateur telescope-builders in this country alone have made their own reflectors, and what is more, are using them to excellent advantage. The British Astronomical Association reports great activity among its members in this most charming and instructive enterprise in other parts of the world, showing the increasing interest in star-study with the aid of home-built instruments. Time was when astronomical research was confined solely to the great observatories, and for the amateur was an expensive hobby. Books on the subject were scarce and materials costly; and if the amateur could not afford a professionally made telescope, the difficulties to be encountered were such as to discourage him in attempting to build his own.

Not so today. Books and magazines offer tried and accurate instruction, and everything from the glass blanks for the speculum to the discarded automobile parts for the mounting (including abrasives, pitch and polishing rouge), may be had for half the cost of the home-built radio—everything, in fact, save the brains and patience that are required to do anything worth while, and not an extraordinary amount of either. Indeed, the fact that in at least ten of the large cities of the country amateur telescope-builders associations have sprung up, many with large membership, attests the truth that what Prof. Turner calls the "non-professionals" are vieing with one another to produce efficient instruments, and what is more, *using* them not alone as a pleasant pastime, but in work with a definite scientific purpose.

Home-built telescope of Sir Isaac Newton

Reflector More Economical

THE reflector offers itself to the amateur optician in preference to the refractor for the following reasons: it is cheaper, an eight-inch disc of high grade commercial plate, one and one-half inches thick, costing five or six dollars, while glass of an optical grade suitable for a lens would cost a hundred. Then with a refractor there are four surfaces to grind, polish and figure, while with a reflector only one—the concave surface which receives the image of the star and reflects it back to the diagonal fixed in its optical center and on to the eyepiece outside of the tube. The silvered mirror has the additional advantage of giving a clear, sharp image of a star without chromatic aberration, which is the reason that reflectors are now used almost exclusively in astro-photography. Cheapness, ease of construction and efficiency make the reflector the amateur's own.



The simplest telescope is shown here. No tube is used.

Little did Sir Isaac Newton dream when he built his midget two-inch reflector that bears his name and showed it to the Royal Society of England, that in coming years men would be building them fifty times as large, or as is in present prospect, with a speculum sixteen feet in diameter! And yet, in building your telescope you will be following Newton's principles of optics, as seen

* *Author of "1001 Celestial Wonders as Observed with Home-built Instruments," Pacific Science Press, Morgan Hill, Calif.*

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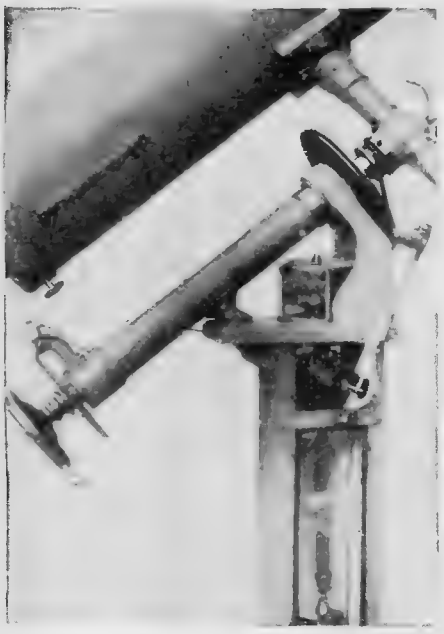


The above photograph shows a home-made tripod mount to be used with the reflecting telescope. A protractor declination-circle may be installed to facilitate meridian observation.

in the accompanying diagram.

You may devise original plans for a mounting, but the idea of the optical train remains the same in all, great and small. As the mirror is the all-important factor, let us take up the matter of its construction first. You will therefore need the following:

Supplies Required

TWO eight-inch discs of plate glass, (*a*) 1½ inch thick, for speculum; (*b*) ¾ inch thick, for the tool. Cost of pair, about $6.00.

The photograph above shows the mirror, tool and grinding post at the completion of the fine grinding. The tool is cemented to the top of the oil drum.

(*Editor will furnish names of makers on request.*) One 8 x 8 inch pine post, bench-high, anchored at base, with space to walk around it. Screw to top a 10 inch circular plank, levelled. Cleat tool to same firmly. Cut an 8 inch disc of pine, one inch thick, and screw to center an upright handle. Smear other side with hot pitch tempered with turpentine, and set speculum upon it, previously warmed. Allow to cool under weight. Purchase at any good hardware store four or five grades of carborundum, No. 80 to finest carborundum flour—a few ounces of each grade. Also ½ lb. optician's rouge. Total cost, about $1.50.

Two pounds of common pitch will suffice. (Always melt and strain through cheesecloth before using.)

Have on hand a goodly supply of distilled or rain water. (Hydrant or well water is liable to hold grit in suspension and damage your mirror.)

Two aprons are needed, one for the grinding process and one for polishing. Polish in a place as far removed from the grinding as possible.

Start of Operations

YOU are now ready to begin operations. Dampen half a teaspoonful of the coarsest grade of carborundum and smear center of tool. Lay speculum upon it and begin with a circular half motion round and round, turning it a little each time with the handle held in both hands, meanwhile walking slowly around the post. Moisten the abrasive occasionally with a few drops of water. Continue for fifteen minutes, wipe speculum carefully, and lay a steel straight-edge across center. You will observe the curvature at once.

Naturally, the longer you continue grinding the more your speculum will become concave and the tool convex. But you want approximately the right curvature in the rough, so you prepare a template for gauging. A focal ratio of 8 to 1 is about right, so that the distance from mirror to focal point (eyepiece) is 8 times 8, or 64 in., for an 8 inch glass. On a wall twelve feet or so from the ground, attach a steel tape to a nail and measure downward just twice the focal length, or 128 inches. Attach a marker and swing sidewise like a pendulum, scribing the curve against cardboard, sheet tin or glass. Cut out carefully, and the convex sheet will serve as a template to gage the depth of your mirror's curvature. (This work can be done on a smooth floor as well.) Continue the rough grinding until the template almost fits it. Subsequent fine-grinding will complete the true curve.

Further Details of Grinding

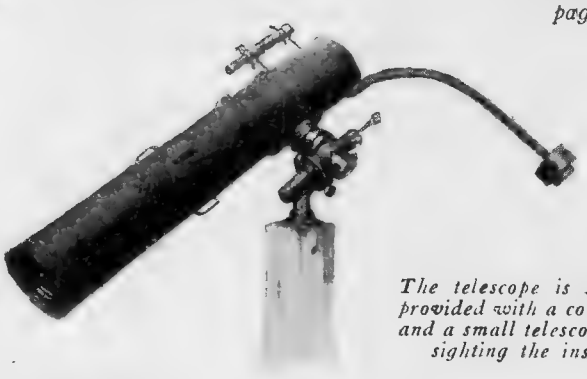
FROM time to time swab off the mirror and flow over with *warm* water (not cold, or you may crack it.) In the sunlight throw the image of the speculum upon a blank wall at about the focal distance. You will observe the bright disc of light growing smaller and smaller till, at the right curvature, it will resemble a brilliant quarter-dollar. Proceed thence with fine grinding.

By this time you will be so delighted with your progress and pleased with your handicraft that the rest will be easy But make haste slowly. Ten or fifteen-minute shifts are better than long sessions. You will also learn to vary your stroke—never twice in succession over the same areas, employing sometimes the straight-across stroke instead of the circular. Proceed with all the finer grades in succession, a half-hour or more with each, as you observe your progress demands, carefully washing away all traces of each grade before proceeding with the grade finer, shaking out apron and scouring hands. On the perfection of your fine grinding depends the ease and speed of your polishing process; hence, at the last, proceed as follows:

The 10-inch speculum enclosed in a wide strip of paraffine paper to hold the chemical is shown above. It is washed with nitric acid and made ready for silvering.

In a *clean* fruit-jar place a quarter-pound of the finest

(*Continued on page* 68)



The telescope is shown here provided with a counterweight and a small telescope to aid in sighting the instrument.

Stellar photography for the Amateur.

A film-pack camera is shown at the right, attached to a 10-inch reflector, in readiness for astronomical photography.

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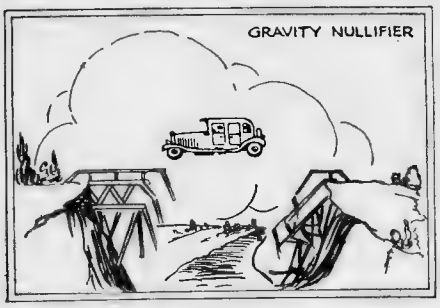
Electro-Magnetism and Gravity Satisfy Same Equation

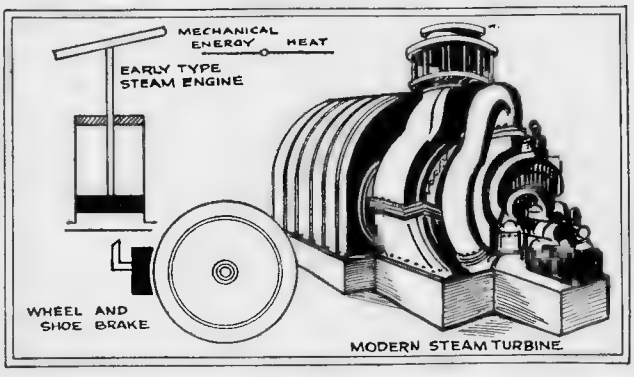
A Popular Exposition of the Latest Advance of Science and Its Significance



The gravity nullifier of the future is illustrated at the right. When roads are impassable, the car takes to the air.

EINSTEIN'S *New* THEORY

By
PROFESSOR
H. H. SHELDON
New York University

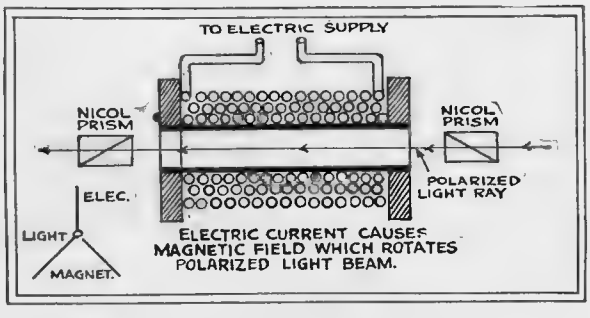


The correlation between heat and mechanical energy was made by Count Rumford (Benjamin Thompson). Before his time, it was thought that heat was a fluid of which a given piece of material contained only a limited amount. A wheel and brake show the relation between mechanical energy and heat.

PERHAPS nothing expresses so clearly the situation with regard to the advance of science as does that poem by John G. Saxe,—"The Blind Men and the Elephant." As children we were undoubtedly all familiar with it, but let me refresh your memory with at least the opening verse.

It was six men of Indostan,
To learning much inclined,
Who went to see the elephant,
(Though all of them were blind),
That each by observation
Might satisfy his mind.

You will recall perhaps that one observer, bumping into the side of the elephant, immediately jumped at the conclusion that it resembled a wall. The tusk seemed to another like a spear.

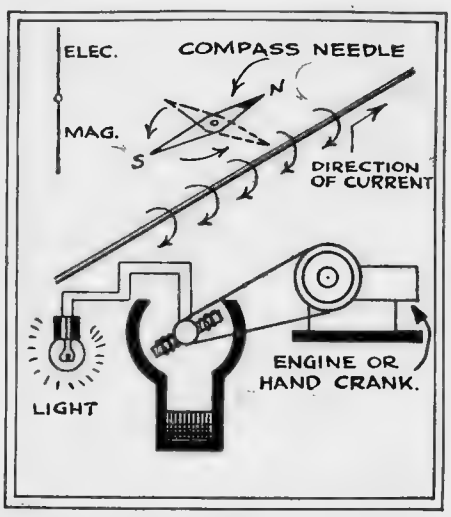


Clerk Maxwell, in 1864, demonstrated that light was an electro-magnetic phenomena. The above illustration shows how an electric current causes a magnetic field which rotates a polarized light beam. Light and electro-magnetism have been correlated.

And so the elephant was described as a snake, a tree, a fan and a rope.

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong;
Though each was partly in the right,
And all were in the wrong.

For centuries we have been groping about the elephant. We have described various physical phenomena as light, heat, gravitation, electricity, magnetism and so on. And although thousands of us have been "to see the elephant," only occasionally does any one have sufficient breadth of mind to observe any relation between one part and another. When this happens there are many to shout that he is wrong.



In 1820 Oersted found that a magnetic needle placed near a wire carrying a current was deflected. Magnetism and electricity were correlated and upon this discovery all our modern electric motors and dynamos are based.

Light and Heat

ONE of the simplest of these correlations to make was undoubtedly that between light and heat. These have been associated in the mind of man from the earliest times. The warmth of the sun would at once suggest this, even ot the most primitive of people. And we know now that light and heat are one and the same thing. A child with a burning glass demonstrates it.

Heat and Mechanical Energy

THE next correlation to be made was delayed for centuries. This was the correlation between heat and mechanical energy. That this discovery was made by a man born in America is perhaps not generally known. Count Rumford (Benjamin Thompson) was born at Woburn, Massachusetts, in 1753. A Tory, he moved to England during the revolution, and later went to Munich. Here, he became Minister of War and made his famous discovery while in this capacity, by observations on the boring of cannon. Before his time it was thought that heat was a fluid of which a given piece of metal contained only a limited amount. Count Rumford observed that regardless of the length of time the boring tool ran, heat was still

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obtained. Measurements on a blunt tool convinced him that the amount of heat depended upon the mechanical energy put into the turning of the drill. Joule, an English physicist, by a series of brilliant experiments, extending from 1842 to 1870, placed Rumford's discovery on a thoroughly scientific basis.

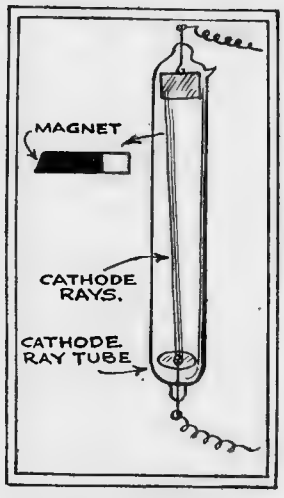
Before Rumford's time only the crudest sort of steam engine had been invented. Our modern locomotives, gasoline and Diesel engines—our age of power may rightly be considered outgrowths of this first epoch-making discovery.

THE LATEST CONTRIBUTION TO SCIENCE

THE scientific world was startled but a few weeks ago by cables from Europe telling of Einstein's present work. He has derived an equation which fitted the facts of both gravitation and electro-magnetism, just as Maxwell derived one which fits the facts of light and electro-magnetism. Unfortunately, the correlations are so complex, it will require some one, other than Einstein, to make his theories clear to the layman. Prof. Sheldon has given us a non-mathematical description of the new theory and its significance.

Electricity and Magnetism

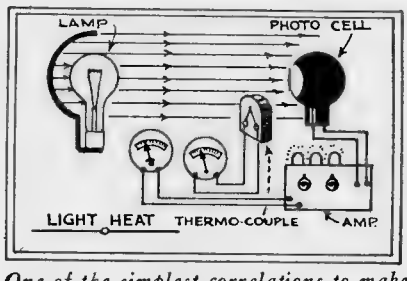
THE next great discovery was that of Oersted in 1820. He found that a magnetic needle, placed near a wire carrying a current, was deflected. A current has around it a magnetic field. It was the first evidence of a correlation between electricity and magnetism and created as much excitement in its day as did Einstein's recent work. Thereafter the two phenomena were regarded as interrelated. Scientists spoke of electro-magnetic phenomena. Upon this discovery is based all our modern electric motors and dynamos. Without it we would know nothing of our modern electrical age. It enabled us to change electrical to mechanical energy and the reverse.



The relation between magnetism and electricity is illustrated by the deflection of cathode rays by a permanent magnet.

Light an Electro-Magnetic Phenomena

THE third great correlation came as a purely mathematical speculation. In this respect it resembles more nearly the present work of Einstein. It was a more difficult correlation to make than Oersted's, just as this was more difficult than that of Rumford, and his more difficult than the correlation of light and heat. This was the deduction by Maxwell in 1864 that light was an electro-magnetic phenomena. 1864 is a date perhaps within the memory of many of my readers. We are getting close to home. Maxwell's brilliant mathematical reasoning was quickly put to test by Hertz, who demonstrated that electro-magnetic waves behaved in a manner similar to that of light. This was soon put into commercial form by that eminent engineer, Marconi. We have arrived at the age of modern broadcasting and of television. Who would have dared to have predicted this from a study of Maxwell's equations?



One of the simplest correlations to make was undoubtedly that between light and heat. A photo-electric cell and a thermo-couple show this clearly.

Einstein

BUT are we to stop here? Can we not show a sameness of other physical phenomena? In this field Einstein has perhaps led all his predecessors. He has not been a blind man who felt of but one part of the elephant. He has not even been a blind man who felt of two parts and concluded from careful study that they were one and the same thing. It would appear that he has not even been a blind man at all, but rather has approached the elephant with his eyes wide open. And perhaps too he has taken an occasional X-ray picture of the animal. He has unfortunately found the correlations so complex that he has been unable to make many of us visualize this elephant by his descriptions. It is much like trying to visualize an automobile from blueprints. It will require someone other than Einstein to make his theories clear to the laymen. Many have done well in this field but all have failed. It requires a super-Einstein and of that there is little hope.

Non-Euclidean Geometry

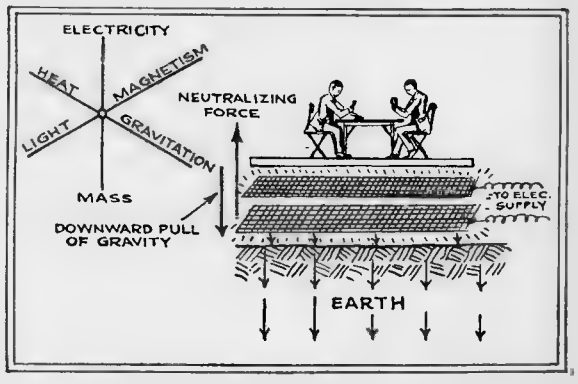
ONE of the great difficulties in understanding Einstein, lies in the fact that all his deductions are based on a non-Euclidean geometry; and this is something quite apart from any ordinary experience. Let us see what this geometry is. We are accustomed to think of parallel lines as those which do not meet. We are accustomed to triangles, the three angles of which equal 180°. If we take a sheet of paper and draw parallel lines and a triangle upon it, they will retain their properties so long as the paper is not stretched in any fashion. But draw the figures on a piece of rubber and then stretch it so that it fits over a ball or sphere. The lines which were parallel may now definitely slant toward each other; the three angles of your triangle will no longer equal 180°. A straight line is no longer the shortest distance between two points. Great circles of the sphere now take the place in our minds of what we formerly called straight lines. Our whole geometry is changed. We are now dealing with spherical geometry, rather than plane geometry.

Reimann Metrics

SUPPOSE now we go to a more complicated case still. Suppose we try to form a new geometry for figures placed upon a surface like that of an egg. A triangle has properties now which depend upon its position on the surface. To specify a triangle we must also say where it is. Let us extend our case to one of a dumb-bell, a hubbard squash, or any other irregular and perhaps even non-symmetrical figure. Our mathematics now becomes highly involved. In fact, it is necessary to develop an entirely new mathematics to take care of such cases. Our usual mathematics has grown up from cases of actual practise. This new fund of material is far beyond our daily needs. Reimann has perhaps been foremost in the development of the tools for such difficult cases. Einstein has been first in their use. Thus we read of such terms as "distant parallelism," meaning that a line may be parallel to another at a distant point on the figure. It may be quite impossible for two nearby lines to be parallel. The study is not even confined to a three-dimensional figure, such as those we are acquainted with, but is extended to a four-dimensional continuium. Plane geometry deals with two dimensions, spherical is a particular case of three-dimensional geometry. The Reimann metrics is capable of dealing with even more dimensions.

All this is so completely outside of our general experience that to those not working in the field it becomes meaningless. But to Einstein and his followers it is fraught with great significance. Many of the future (*Continued on page 87*)

What is the significance of the new theory? Will future man neutralize gravity?



In the future, gravity may be nullified by electricity as suggested above. The new theory states that energy mass, light, heat, gravitation, electricity and magnetism are inter-related and interchangeable phenomena.

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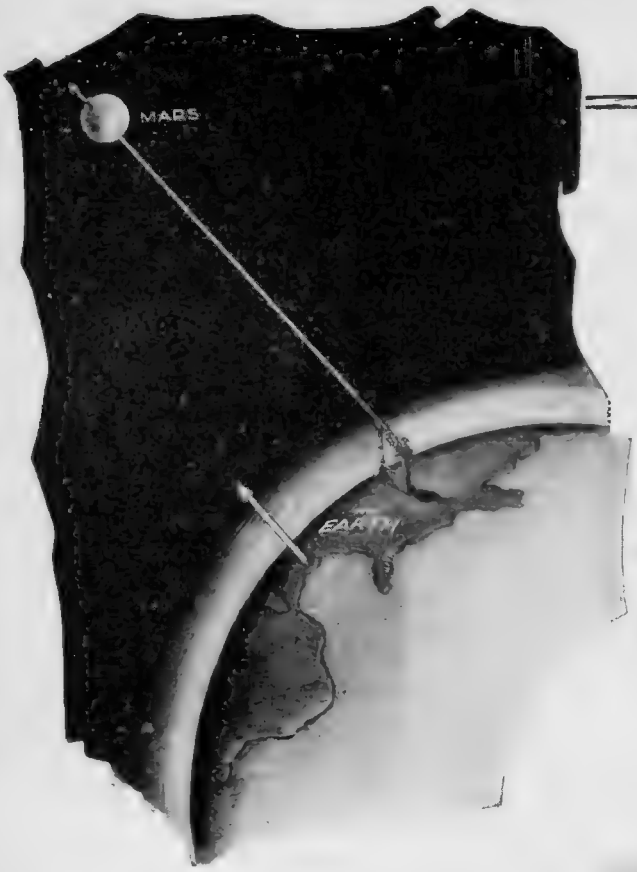
Curious Facts About Time



Above is a signal from Mars. The problem is to calculate the time it was sent. We are unable, however, to do this, for if both planets are moving in the direction of the arrows at an unknown velocity, we travel an unpredictable distance to meet the signal flash.

Space, Time, and Relativity

By DONALD H. MENZEL, Ph.D.

Part Three of a Series Dealing with Einstein's Space, Time and Relativity Theories. These Articles Are Presented in a Manner Easily Understandable to the Uninitiated and Provide Interesting Reading and Much Food for Thought

A Relativist, a Physicist and a Layman Discuss the Subject

RELATIVIST: It is easy to understand why the simplest words are the most difficult to define. We rely on experience rather than definition for our fundamental ideas. To Flannery, "pigs is pigs" rather than "omnivorous mammals having a long mobile snout with flat expanded end containing the nostrils." In relativity we deal with time and space and although they are apparently simple words, it is necessary to know explicitly what they mean.

Physicist: The dictionary says that time is a measure of duration.

R: What is duration, then?

P: Duration is the time during which anything lasts.

R: Worse and worse. We are no better off than we were when we tried to define space* and learned that a foot is twelve inches while an inch is a twelfth of a foot. We might as well have said, "Time is time."

What Is Time?

LAYMAN: Even though you may find it difficult to define time, we know very well, from experience, what it is.

R: I'm not so sure. In that case of our definition, "pigs is pigs," all we need to do is pick out some animal with certain characteristic and say, "This is a pig." Then if we find another animal that has these same characteristics we also call it a pig. Notice that there are two operations involved. First we decide what features are to determine whether a given animal is a pig or not. The second operation involves actual comparison with the standard.

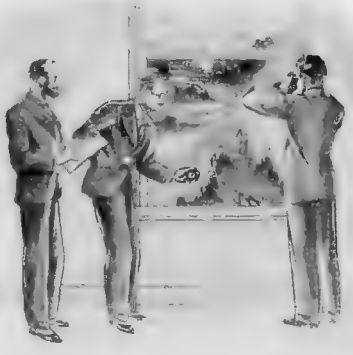
Similarly we may say, "This is a foot," and then use our standard to measure distances—say the length of a room. But notice that the foot did not define itself any more than the pig did. We had to choose our standard and then live up to it.

When we come to time, however, I am quite at loss as how to proceed. Where is our standard for time? Did you ever see time? or hear it, or smell it?

L: I can see a clock.

R: But the moment you introduce a clock you cease to talk about time. You are dealing with measurement of time—which is quite another thing. But discussing measures of time may help. What method do you suggest?

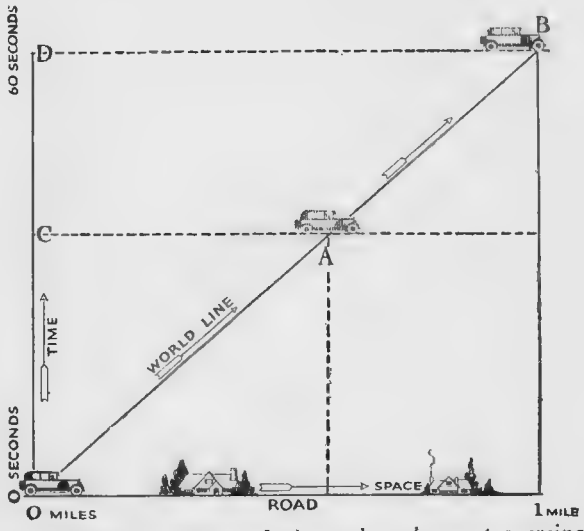
(*Continued on page* 91)



Above, we see the relativist, layman, and the physicist testing the whistle of a train.

**See last month's article.*

The geometer draws a picture of the street showing how Mr. Smith's car travels along it at a mile a minute.



The relativist pictures both road and car traversing through time. Dotted parallel lines show successive positions of the road. If the car had been motionless, its progress would have been through time alone and it would appear successively at C and D. Since the car is travelling along the road, its successive positions are indicated by the diagonal line, such as, points A and B.

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This is a new magical novelty which resembles somewhat a mind-reading trick. The magician shows a small box containing two compartments, and fitted with a hinged cover and hasp. Two letters appear on the outside of the box, A and B, to designate the respective compartments. A wooden block is made just large enough to fit into the compartment. While the wizard is absent from the room, the block is placed into either of the compartments by any member of the audience. The lid is closed securely, and then the magician is recalled. As he enters the room, he immediately calls the letter of the compartment containing the block. As will be seen, the brass ornamental lock on the box turns slightly and it indicates which compartment contains the block. A projecting peg attached to an endless chain is the agency by which the lock is turned when the block is pushed into one or the other of the compartments.

INTERESTING TRICKS FOR ANY ENTERTAINER

Tricks for Amateur, Parlor, Lyceum and Professional Entertainer

Magic

By DUNNINGER

NUMBER SIXTY-NINE OF A SERIES

The Mystic Wand

HERE is a wand apparently possessed with supernatural powers. When placed on the table, and merely touched, it rises up and stands on end as if drawn into this position by some magnetic

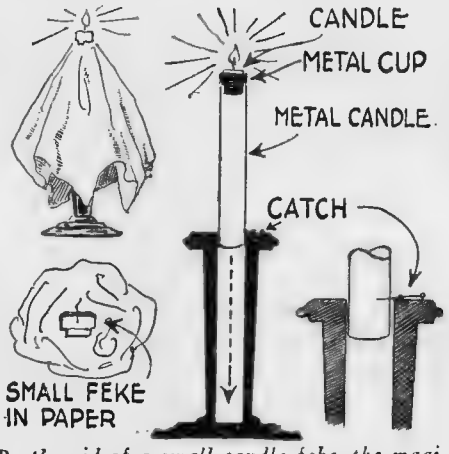
This aluminum wand will rise into an upright position because it is made of thin material and contains a heavy lead ball. For further explanation see text.

power. The construction in this case is clearly indicated in the diagram. The thinnest aluminum securable is used for making the wand. Two round ends are fitted to it, and a lead or steel ball is placed within. The wand is then painted black with the exception of the two ends. If the stick is started, it will stand up on end on a principle similar to that employed by the toy manufacturers in making the ever-popular "roly poly" toy. The table may have to be inclined slightly for best results.

Vanishing Candle

IN this effect the magician's assistant brings forth a large candle in a metal candlestick. The candle is lighted. The magician then tears a hole in a paper napkin, pushes it down carefully over the burning candle, and then apparently picks up the entire candle, together with the paper napkin.

With a quick sharp movement, the magician crushes the paper between the palms of his hands, and rolls it into a small ball. The candle has mysteriously vanished. The explanation is given in the diagram. The candle itself is made



By the aid of a small candle feke, the magician finds no difficulty in apparently vanishing a candle of quite large proportions.

of metal, and secretly drops into the hollow of a candlestick. What seems to be the lighted candle, is really a small feke, in a metal cup, which is concealed in the paper napkin during the act of rolling it into a ball.

Resurrection

THE illusionist asks for a loan of a gentleman's handkerchief. He displays this constantly to prove that there is no substitution. Then, picking up a pair of scissors, he snips a large piece

The blades of the scissors are kept far apart. The metal tube contains a disc of linen. By this means, a kerchief is apparently cut and restored.

out of the center. When the spectator objects, he picks up the cut piece, rubs it against the handkerchief, and restores the latter in its original condition. The secret lies in a specially-prepared pair of scissors, the blades of which are dull, and are held far enough apart to permit a handkerchief to slide between them without cutting or injuring the fabric. A tube attached to the bottom of one blade contains a piece of fabric which is pushed out by the thumb during the act of cutting. A metal slide is the agency. The cut piece is palmed.

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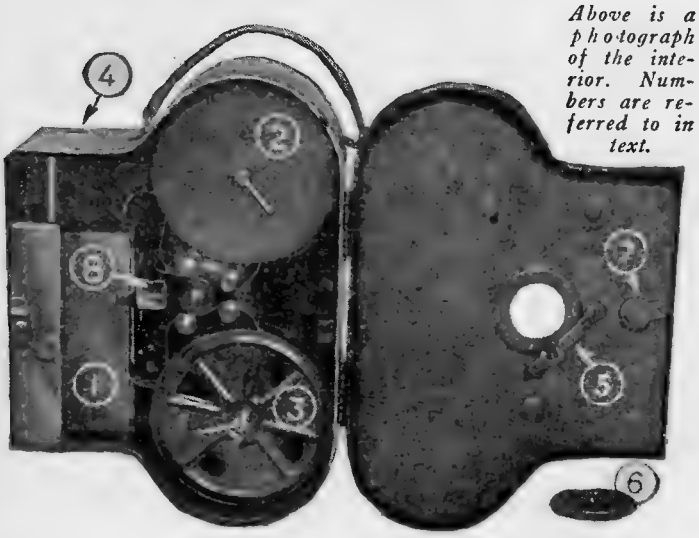
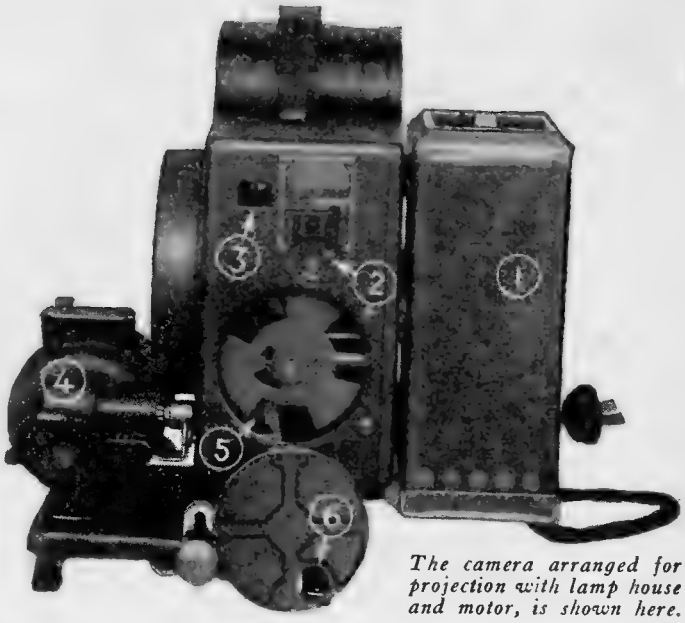
"Two in One" Instrument for Home Movie Fans

Same Instrument Can Now Be Used for the Taking and Projection of Amateur Moving Pictures



Above is a photograph of the interior. Numbers are referred to in text.



The camera arranged for projection with lamp house and motor, is shown here.

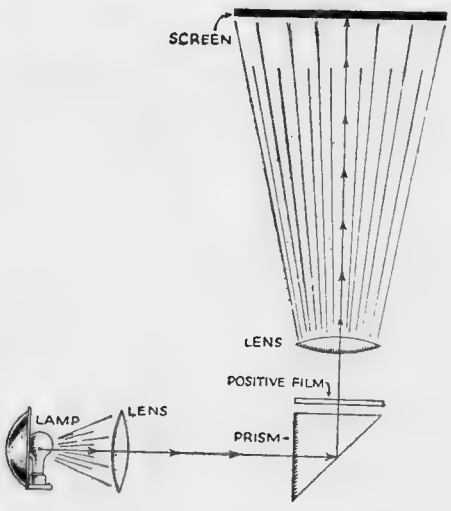
New Combination Camera *and* Projector

OF interest to those engaged in amateur moving pictures, is a new combination camera and projector which takes up little space, is readily portable and always convenient for immediate use. The carrying case is provided with compartments for all parts and equipment.

The Camera

THE camera operates by a spring motor or by an attachable hand crank. The latter is used for fast or single frame exposures. The lens of this instrument serves as both the camera and projection lens. No focusing is necessary, as it is of the fixed focused type. Both waist level and eye level view finders are provided and are gauged to cover the same field view as the lens. In the photograph of the interior, 1, shows the housing covering claw and feed mechanism, 2, feed reel, 3, takeup reel, 4, level finder, 5, lens compartment circle door, 6, light proof door disc, 7, door latch, 8, prism and prism bracket. Light proof spools with closed sides are used for the film when taking pictures.

Only one adjustment is necessary for three positions on the entire camera and projector optical system. These are the diaphragm stops and are used only when the instrument is employed for taking the pictures. One winding of the spring motor will run 25 feet of film. A large key is inserted in the right side of the instrument for rewinding the motor, after it becomes run down. A footage dial on the back of the camera tells exactly the number of feet of unexposed and the number of feet of exposed film.



The above drawing shows how the projector operates. A prism is used which bends the light at right angles to its axis of propagation.

Projector

IN order to convert the camera into a projector, the front of the circle door is opened and the camera shutter removed. The projector shutter is then inserted in its place. In order to connect the lamphouse, the light proof disc is removed and the key slots at the upper section and a snap slot at the lower section of the camera door permit installing the lamphouse in a rigid position which guarantees alignment of the optical system between the lamp, lamphouse, condenser and prism, in the camera. The projector operates by a hand crank or an electric motor of the universal type. The photograph at the top of the page shows the instrument arranged as a projector with 1 designating the lamphouse, 2, the lens diaphragm indicator, 3, front view finder, 4, electric motor, 5, projector shutter, 6, lens compartment circle door. After the film has been projected, it is rewound on the upper reel spindle, using the camera hand crank.

All Motion Tripod Head

SHOWN in the above photograph is an all motion tripod head usable with all types of amateur moving picture cameras. The illustration at the left shows the flexibility of this type of mounting. Any camera angle can be obtained and the tripod head locked in position if desired. A handle is provided for quick and easy adjustment with thumb nuts for locking in position. The mounting of the camera upon the head is effected by means of a machine screw placed through its top.

Names and addresses of manufacturers on request.

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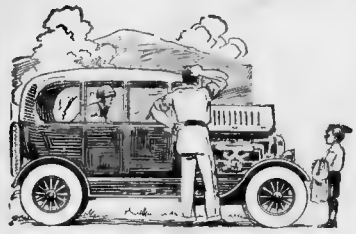
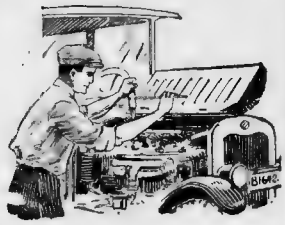


Motor Hints

Conducted by
GEORGE A. LUERS



Patching Cracks in Engine Castings

WHEN the automobile freezes, due to lack of proper precautions to protect against this, the owner should not be discouraged; there are several methods of repair.

Electric welding of the casting is possible without removing the engine. This work is done only by an experienced welder; however, it is not nearly as expensive as renewing the castings.

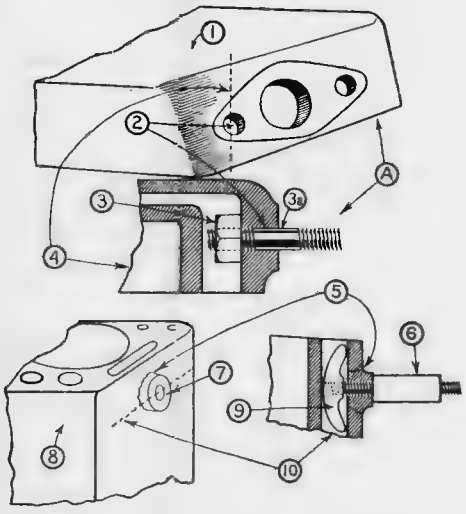
Many times it is possible to put on a "soft" patch, using a piece of eighth-inch copper or brass, secured with screws about an inch apart, placing under the patch a piece of burlap or canvas, thoroughly coated with red lead.

For small cracks and breaks, the owner can use only a small quarter-inch iron rod, threaded for quite a distance. Drill a hole at one end of the crack, tap out and screw in the rod. Cut this off flush and drill, tap and screw in another section of rod, to overlap the first. Continue this until the full length of the crack is closed.

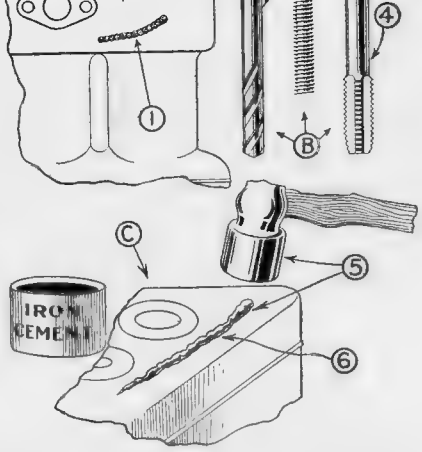
Iron cements are excellent for cracks. Most owners do not know how to apply these, which is the entire secret of success. Spread the iron cement along the crack. (There are several good ones available.)

Use a hammer to drive this down into the crack. The cement should be quite a stiff mixture. Continue to lay on the cement and hammer it into place. An excellent repair for cracked castings is carried out in this way.

These excellent repairs easily enable the car owner to recondition his auto after the disastrous winter months.



Stripped threads in engine castings can be repaired as illustrated. 1, *cylinder head,* 2, *stripped threads,* 3, *nut,* 3a, *stud,* 4, *section through the dotted lines,* 5, *brake,* 6, *fan stud,* 7, *fan stud lug of engine,* 8, *cylinder casting,* 9, *manifold clamp, and* 10, *indicates section through dotted lines.*



Above—A, repairs with threaded iron rod, 1, *rod, B, shows tools for repair,* 2, *tap drill,* 3, *threaded iron rod,* 4, ¼-*inch tap, C, iron cement repair,* 5, *cement driven in crack with hammer,* 6, *cement*

DO YOU KNOW—

steering a car with a stiff or loose steering gear is one of the most tiresome duties of driving, never permitting the arm muscles to relax. Stiffness is cured by lubricating. Lost motion can be eliminated partly by adjustments provided, while new bushings in the steering knuckles and tie rod will complete the removal of looseness.

Repairs for Stripped Threads

Stripped threads in engine castings occur when the owner puts more than usual effort in tightening bolts to stop leakages or in cases where threads get crossed in starting bolts.

A frequent breakage point is at the front radiator connection to the cylinder head casting. As a means for quickly repairing this, the method shown in the sketch will appeal to the owner because it is simple and can be applied without loss of time. A stud and nut placed in the casting, will repair the damage and make as tight a job as the original.

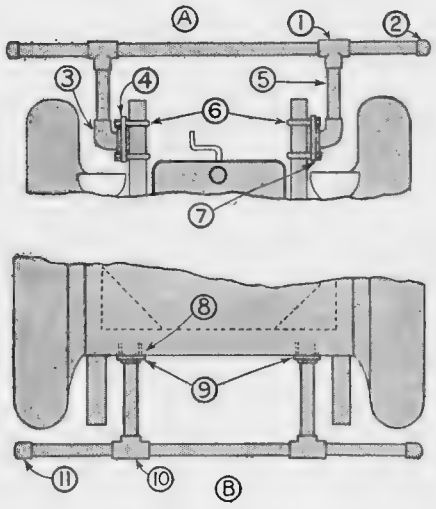
Another frequent damage is the breakage of lugs around the cylinder casting such as the lug on some castings supporting the fan stud. An effective repair for this breakage and also a repair for stripped threads in this lug is by means of a manifold clamp of the Ford type illustrated by the sketch.

A longer threaded fan stud is used and the clamp is placed in the water jacket space of the cylinder. Before tightening the repair, the broken area in the casting should be coated with heavy red lead.

These simple repair methods are illustrative of means which can be adopted inexpensively for similar breaks or stripped threads without loss of the service of the car while making more extensive repairs.

Gas Pipe Bumper for Light Trucks

Bumpers are important details of equipment for passenger cars and on trucks these are of equal importance, though not frequently used. The usual advantages are those of protecting the lamps, fenders, radiator and wheels. Additionally, a car fitted with a bumper can be used to push another car. When a car is stalled for reason of shortage of gasoline, broken drive shaft or transmission, or when stuck in a hole, another bumper equipped car will push it to a service station out of trouble.



The front bumper is shown above at A. 1, *tee,* 2, *cap,* 3, *elbow,* 4, *flange,* 5, *pipe and fittings,* 6, *'U" bolts,* 7, *bumper bolted with spring hangers. B, shows a rear truck bumper,* 8, *indicates where bumper is bolted to frame,* 9, *pipe flanges,* 10, *pipe tees, and* 11, *pipe cap.*

As cheaply made, but thoroughly serviceable bumpers, those used on some light one and a half ton trucks in the plumbing trade are shown as examples of equipment readily added by truck owners, who recognize the advantages of this equipment.

One and one-half inch iron pipe and fittings are the material of these bumpers. Only pipe cutters and threading dies are required to fit them up.

"U" shaped bolts of half inch iron bar secure the front bumpers, while bolts and nuts fasten the rear bumper.

The necessary detail information is shown in the attached sketch and it will be obvious that these can be duplicated readily.

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The Art of Masking in Amateur Productions

HOME MOVIES

By DON BENNETT

How to Build a Mask Box at Small Cost Which Can Be Used for Giving a Professional Touch to the Home Photoplay

IN a darkened room in a house in the residential section of Rockland a dozen people were gazing expectantly at one of the walls. A hush had settled over the room and all was quiet save for the occasional creak of a chair.

The stillness was broken by the whirring noise of a projector and a white beam of light traveled to the screen, resolving itself into a picture. On the screen a group of people moved around, going through motions with body and lips. The scene ended and a slate took its place, a slate bearing a mystical slogan (Fig. 1A).

After a second or so this was replaced by the same scene as before with slight changes in action and this scene was followed by another slate. This performance was repeated until several hundred feet of film had been run through and the room lights were flashed on. The silence continued for several seconds until a voice said, "Well—?"

"Fine."

"Maybe?"

"Something lacking."

"Take it over."

"Wait a minute, all of you. Let's get this one at a time and see just what's wrong. I declare I'm not satisfied at all with it. The acting is O. K. The lighting and exposure are satisfactory, but something is lacking."

Why a Mask Box is Needed

"IF I may be permitted to speak, gentlemen, I might offer a suggestion?" All eyes turned toward the speaker, Mr. Jones, the amateur movie dealer of Rockland, who was the guiding hand of the Rockland Movie Club. Reading assent in their eyes, he continued, "What seems lacking is that touch of the professional cameraman, whose work you have studied in theatrical work. Your photography was satisfactory, Mr. Blake, as far as ordinary work is concerned, but you missed the beauty of the professional. And all that is needed is a very simple piece of apparatus, a mask box."

"But Mr. Jones, they cost too much!"

"Why not make one? All that is needed is a little patience and experimental work. The materials can't cost over five dollars and you have enough mechanics in the club to make one."

"I'll make it, if you'll tell me how, Mr. Jones," said Blake.

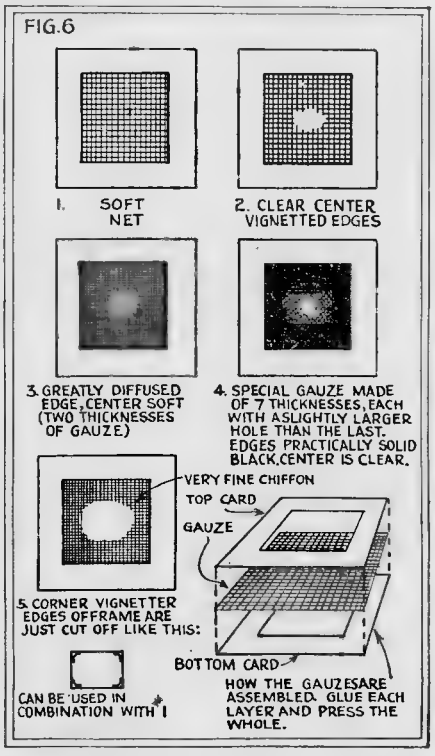
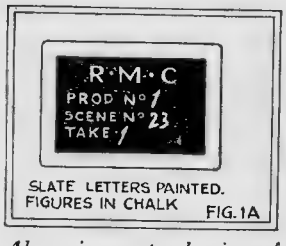


FIG.6
1. SOFT NET
2. CLEAR CENTER VIGNETTED EDGES
3. GREATLY DIFFUSED EDGE, CENTER SOFT (TWO THICKNESSES OF GAUZE)
4. SPECIAL GAUZE MADE OF 7 THICKNESSES, EACH WITH A SLIGHTLY LARGER HOLE THAN THE LAST. EDGES PRACTICALLY SOLID BLACK, CENTER IS CLEAR.
5. CORNER VIGNETTER EDGES OF FRAME ARE JUST CUT OFF LIKE THIS:
CAN BE USED IN COMBINATION WITH 1
VERY FINE CHIFFON
TOP CARD
GAUZE
BOTTOM CARD
HOW THE GAUZES ARE ASSEMBLED. GLUE EACH LAYER AND PRESS THE WHOLE.

A few of the various kinds of "gauzes" are illustrated above. These are pieces of net and chiffon glued in a square of cardboard and selected for their degree of diffusion and pattern.

Requirements of Mask Box

"ALL right. Let's figure out just what you want to use it for and then we can tell better how to build it. In the first place you want it to hold *gauzes*, which are the materials used to vignette the edges and make them appear *soft* and diffused. Then you will want to use various kinds of filters and *effect filters*. And of course there is a multitude of trick work opened up to you by the use of masks.

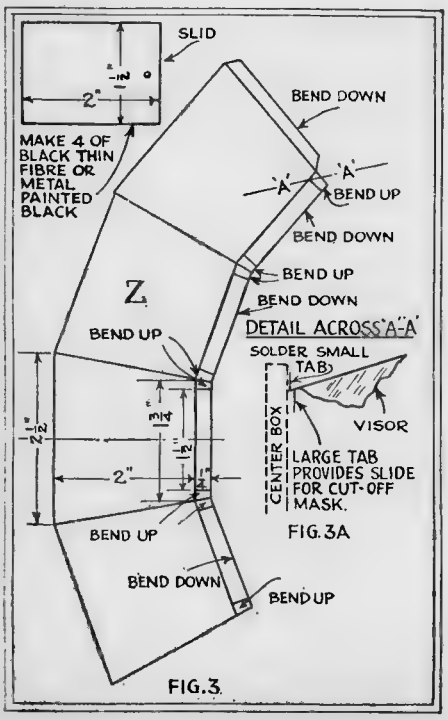


Above is a reproduction of the slate which appeared at the end of each scene.

"The effect filters are made in two-inch squares, and regular filters can be purchased in that size also, so we shall base our measurements on using a two-inch square. The best material to use is brass or tin, bending the visor of the box out of the metal and soldering on the extras. When it is finished a coat of flat black paint will prevent reflections into the lens from the outside surface of the attachment.

Construction Details Simple

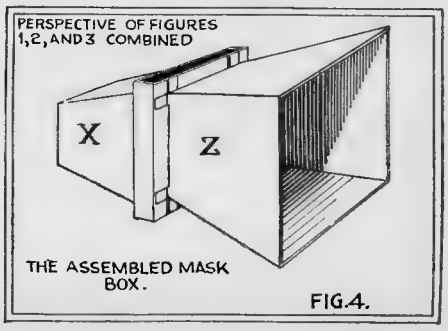
"WE'LL sketch it out, starting with the center of the attachment, the holder. This is bent up from a strip so that it is two inches on each side (measuring on the inside) or just a little over and the side flanges are about three-eighths wide. The width of the center strip should also be three-



The Construction and Use of "Gauzes" Described in Detail

Fig. 3, at the left, shows how to make the front part of the visor. This is made with the small end 1¾ in. on a side, and the large end 2½ in., while the depth is 2 in. Fig. 3a shows how the slide tab is made. This is ¼ in. in length.

The assembled mask box is shown at the right. The beauty of the professional film can be duplicated by using this piece of apparatus with "gauzes" and effect filters as described in the text.



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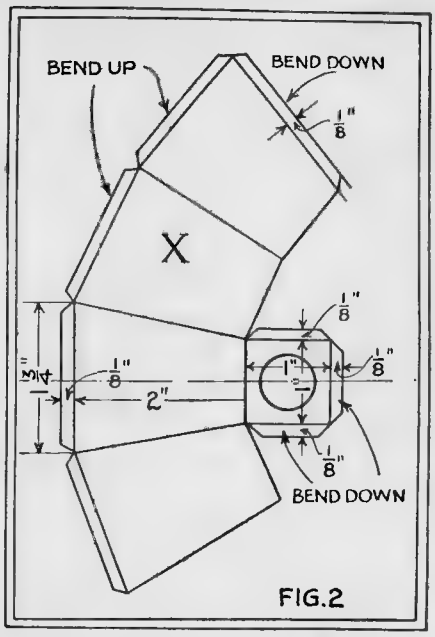
eighths. Bend along these lines (Fig. 1) over a wooden form, and then solder on two strips, each two by three-eighths inches across the top, one on either side. Then lay out on a piece of tin the four sides of the lower pyramid that makes up the visor. These should measure an inch and three-quarters on the long end and an inch on the short end. The visor is two and a half inches long. Allow for a flap for soldering on one edge and a flap on each large end. Leave a flap an inch or so square at the small end to form the back of the visor. Cut in this a three-quarter or five-eighths inch hole, depending on your lens, and small flaps for soldering to the sides (Fig. 2). Bend this up and solder the edge, then solder to the center box.

"The next step is to make the front part of the visor and attach it. This is made with the small end one and three-quarters inches on a side and the large end two and a half inches, while the depth is two inches (Fig. 3). On this section we provide for the cut-off masks, a set of four metal slides, that can be slid into position from any side to block off that portion of the picture. In order to hold the slides in position we must provide some sort of a groove or bearing. We can do this by making a double bend on the inner edge of the front section. Allow for a slide one and a half inches in width. This leaves one-eighth of an inch on each side for fastening. Make the slide tab (Fig. 3A) a quarter of an inch in length and bend it in. Let the one-eighth tab project the thickness of the metal (about one sixty-fourth) and bend it up (or out). The masking slide will then be used between the tab you bent and the surface of the center box. Solder the front section to the box and the attachment itself is finished. Make four slides one and a half inches wide and two inches long of the same metal that the rest of the box is made of.

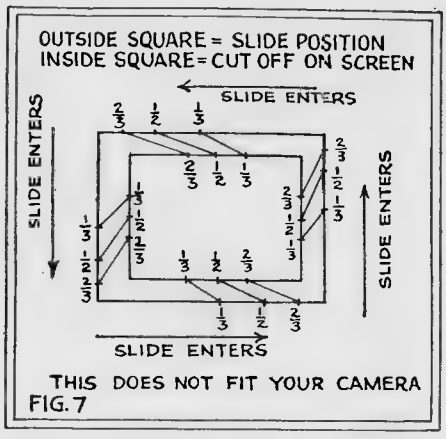


A flap is left at the back end of the visor and a hole cut in this depending upon the size of the lens. A flap is left for soldering on one edge and a flap on each large end.

Attaching Mask to Camera

"OUR next problem is to attach the mask box to the camera. As this will always be used with a tripod, we can escape some hard work and provide for fastening directly on the same tripod. A piece of flat brass, three sixty-fourths inch thick, half an inch wide, and of sufficient length to reach from the center box to the tripod head is all that is necessary. This distance must be measured for your individual camera, as it will vary with each make. In order to make it rigid, we bend the lower end and attach another piece of metal to form a Y. This, fastened to each side of the tripod, will insure rigidity and register of the mask in making double exposures (Fig. 5).

"You will find that two-inch filters and two-inch effect filters will readily fit into the center box and be in register if your support has been carefully made. The center of the lens and the center of the attachment box must be absolutely in line with the center of the film.



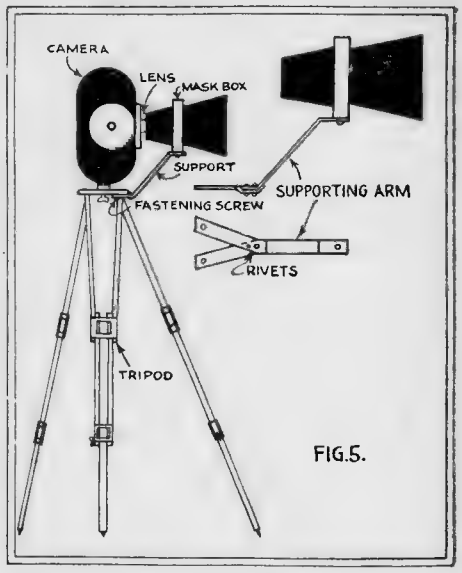
A chart, such as that shown above, can be made for showing the position of the slide for various degrees of cut-off.

How to Make "Gauzes"

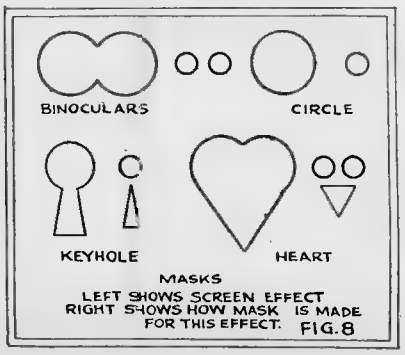
"FOR diffusing the edges or the whole picture, we use what are known as "gauzes." These are pieces of net and chiffon glued in a square of cardboard and selected for their degree or diffusion and pattern. Here are a few of various kinds (Fig. 6). They are mounted in a cardboard square, made up of two pieces, one on each side of the gauze. The margin around is three-eighths of an inch. An infinite variety is possible by using different kinds of cloth, different meshes and different combinations of cloth in the same gauze. There is just one thing to remember, however, and that is that using a gauze increases the exposure necessary. I cannot give you the factors, you must try each gauze until you find its exposure factor. The solid and heavy gauzes will require much more exposure than the ones with the center clear.

"To get the holes through cleanly and without distorting the gauze, a cigar or cigarette is used. Scrape the ashes from the end and shape the burning part to a point. With this any size hole can be made and the edges will be free of stray threads. The burnt threads usually roll up in a little ball of charred material but a slight rotary motion with the finger tips will remove this.

"The cut-off slides are used by inserting them in their proper opening and pushing them in until sufficient aperture has been covered to give you the effect you want. Perhaps the best way is to arrange a piece of ground glass in back of your lens, in the gate, or, if you have a focussing microscope, the lens can be placed in the same relation to the front attachment, as if the camera were in place and the slides set exactly for any cut-off you want. It might be well to scribe a short line on the slide for each position. Mark one-third, one-half, and two-thirds on each slide. Or you may make a chart (similar to the one in Fig. 7 which will not fit (*Continued on page* 88)

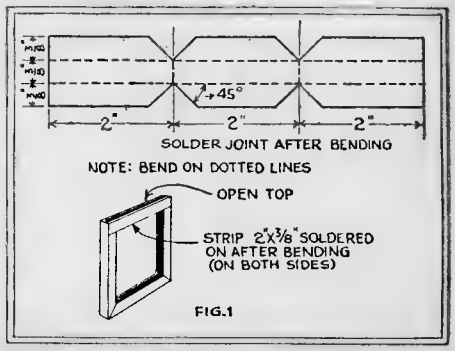


The mask box is attached to the camera as shown above.



Extra slides can be made out of thin fibre and a variety of holes can be cut in them for different effects. Keyholes, binoculars, and a host of other shapes will suggest themselves. It must be remembered that if the shape itself is used as a mask, an entirely different result will be obtained on the screen.

The holder is illustrated at the right. This is bent from a strip so that it measures two inches on each side, and the side flanges are about three-eighths inch wide. Bend along the lines as indicated, then solder on two strips, each 2" x 3/8" across the top, one on either side.



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CHEMISTRY *and* ELECTRICS

A Remarkable New Cell

Invention Promises to Revolutionize Battery Field

By C. A. OLDROYD

EVERY radio fan knows —from personal experience—the drawbacks of a lead storage battery. To get even a moderately long useful life out of this type, many precautions must be observed: normal charging and discharge rates must never be exceeded; the strength of the acid must be kept to the correct figure, short-circuits must be avoided, and so on!

Many will have wondered why the admittedly most progressive electrical industry has not presented us with something better in the way of storage batteries; well—it has not been for want of trying! Engineers and research experts have been doing their best for years to produce a better storage battery, but so far their activities have not brought to light a revolutionary design.

The Almeida Cell

AS it is often the case, a layman—or rather an experimenter—the Jesuit Father, P. Almeida, a native of Portugal, succeeded where engineers failed. After countless attempts, he developed a new type of cell, the design of which is utterly unlike that of our lead or nickel-iron accumulators.

After years spent in research, during the latter part of which he was assisted by European electrical engineers of repute, a marketable type has been produced; the superiority of this new battery over the older types is so pronounced as to appear almost incredible at first sight; but then, nothing seems impossible in the electrical field!

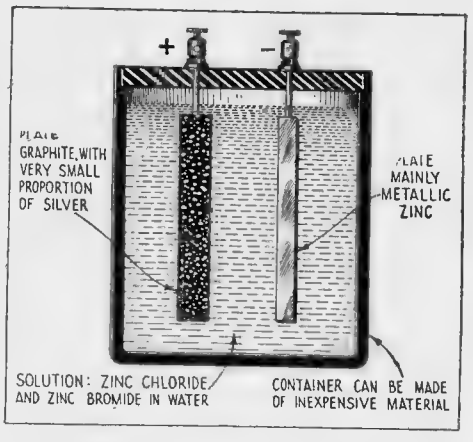

+
−
PLATE GRAPHITE, WITH VERY SMALL PROPORTION OF SILVER
PLATE MAINLY METALLIC ZINC
SOLUTION: ZINC CHLORIDE AND ZINC BROMIDE IN WATER
CONTAINER CAN BE MADE OF INEXPENSIVE MATERIAL

Fig. 1 above is a constructional view of the new cell. The positive plate is made of metallic zinc and the negative, graphite with a small proportion of silver.

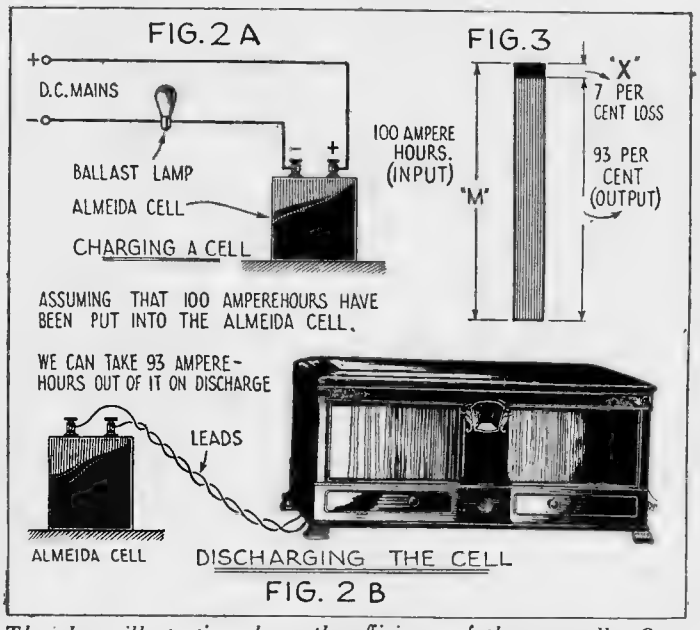
Construction

NO special materials are required for the construction of the new cell; Fig. 1 shows a schematic section of an Almeida battery. The negative plate is made of graphite to which a very minute quantity of silver dust has been added. The silver acts merely through its presence, as a catalytic agent, and is not consumed when the battery is working.

The positive plate consists mainly of metallic zinc, the two plates are immersed in a solution of zinc chloride and zinc bromide in water.

From the manufacturing point of view, the new battery has one great advantage, the plates require no forming; as soon as the parts are assembled the cell is ready for use. Furthermore, no dangerous lead compounds are needed in the manufacture of the plates, no mean step forward as far as the workers' health is concerned.

Sulphation, the dreaded "cancer" of batterydom, for which there is no cure, cannot possibly occur; and even when left idle for long periods the new battery will not slowly discharge itself as lead type batteries never fail to do. A consideration from the production and cost price of view is that the container can be made from inexpensive materials, since there is no acid to attack it.



The above illustration shows the efficiency of the new cell. One hundred ampere hours are put into an Almeida cell, Fig. 2A. In Fig. 3, "M" represents the input energy. "X" shows the loss in per cent. About 93 per cent of the input energy is available and only 7 per cent is lost. Fig. 2B shows the cell on discharge with about 93 ampere hours made available by its highly efficient and unique construction.

Efficiency and Performance

BUT only when we come to actual performance figures can we fully appreciate the immense progress made with the Almeida battery. The point which interests us most is the efficiency of a storage battery; in other words, "how much of the energy put into the battery—when charging—can we take out of it when coupled up, for instance, to our radio set?"

The illustrations show this graphically, supposing we put one hundred ampere hours into an Almeida cell on charge (Fig. 2-A). In Fig. 3, the amount of energy put into the battery is represented by the dimension "M," here "M" is equivalent to one hundred ampere hours. On (*Continued on page 70*)

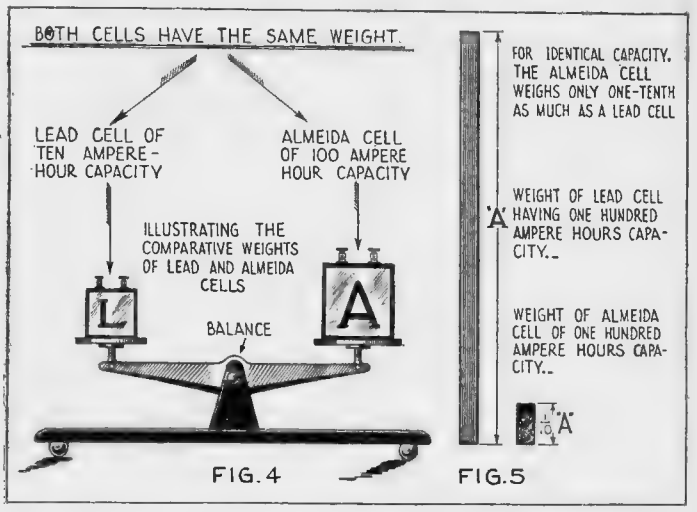

BOTH CELLS HAVE THE SAME WEIGHT.
LEAD CELL OF TEN AMPERE-HOUR CAPACITY
ALMEIDA CELL OF 100 AMPERE HOUR CAPACITY
ILLUSTRATING THE COMPARATIVE WEIGHTS OF LEAD AND ALMEIDA CELLS
BALANCE
L
A
FIG. 4
FOR IDENTICAL CAPACITY, THE ALMEIDA CELL WEIGHS ONLY ONE-TENTH AS MUCH AS A LEAD CELL
"A" WEIGHT OF LEAD CELL HAVING ONE HUNDRED AMPERE HOURS CAPACITY.
WEIGHT OF ALMEIDA CELL OF ONE HUNDRED AMPERE HOURS CAPACITY.
FIG. 5

Fig. 4 above shows the comparative weights of a lead and an Almeida cell. A lead cell of only 10 ampere hour capacity is equal in weight to one of the new cells having a capacity of 100 ampere hours. Fig. 5 shows that the Almeida cell weighs only one-tenth as much as a lead cell. "A" is the weight of a lead cell having 100 ampere hours capacity.

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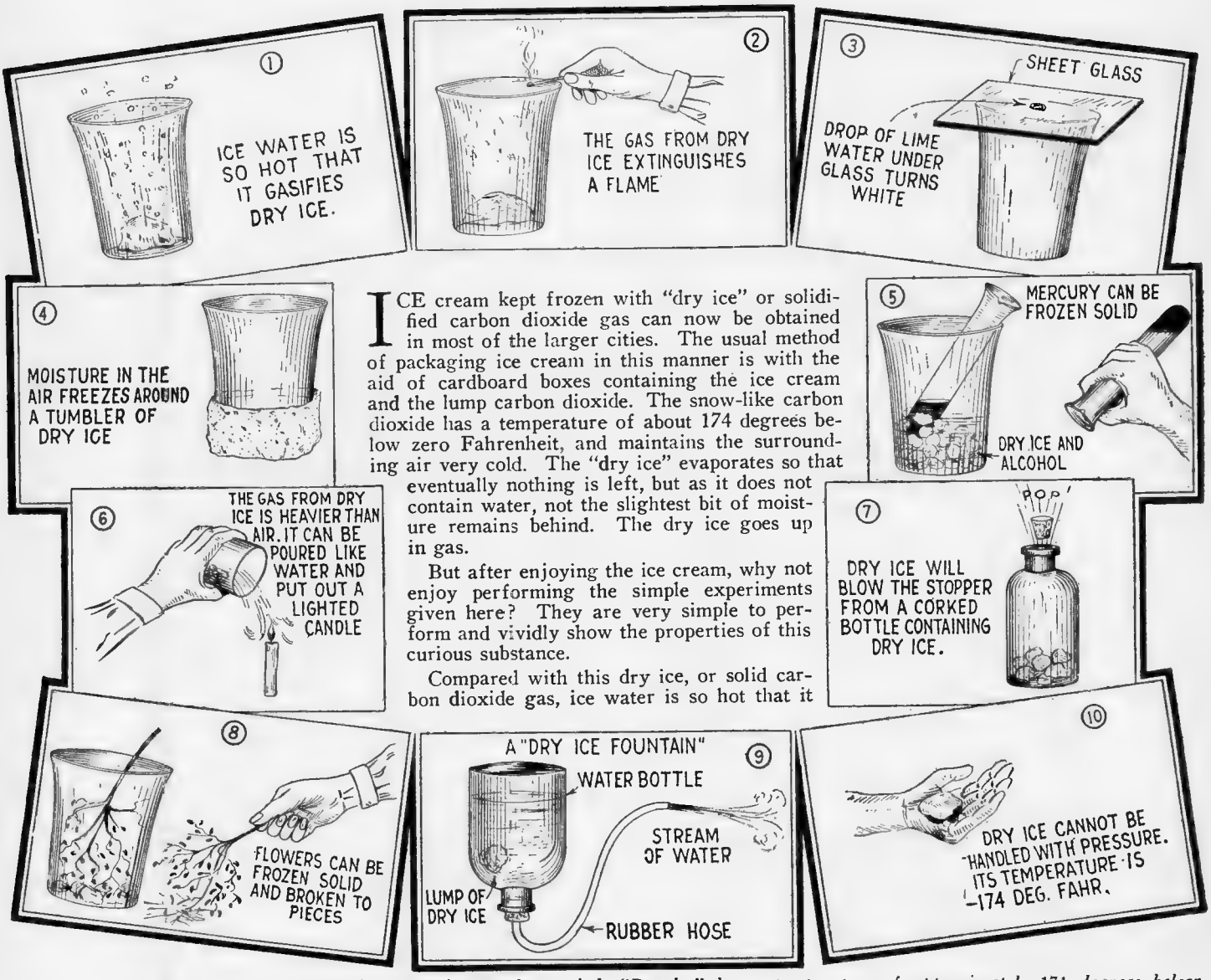
Tricks You Can Do with "Dry Ice"

Solid carbon dioxide gas offers a substance for performing many interesting experiments.

By RAYMOND B. WAILES


1
ICE WATER IS SO HOT THAT IT GASIFIES DRY ICE.
2
THE GAS FROM DRY ICE EXTINGUISHES A FLAME
3
SHEET GLASS
DROP OF LIME WATER UNDER GLASS TURNS WHITE
4
MOISTURE IN THE AIR FREEZES AROUND A TUMBLER OF DRY ICE
5
MERCURY CAN BE FROZEN SOLID
DRY ICE AND ALCOHOL
6
THE GAS FROM DRY ICE IS HEAVIER THAN AIR. IT CAN BE POURED LIKE WATER AND PUT OUT A LIGHTED CANDLE
7
POP
DRY ICE WILL BLOW THE STOPPER FROM A CORKED BOTTLE CONTAINING DRY ICE.
8
FLOWERS CAN BE FROZEN SOLID AND BROKEN TO PIECES
A "DRY ICE FOUNTAIN"
9
WATER BOTTLE
STREAM OF WATER
LUMP OF DRY ICE
RUBBER HOSE
10
DRY ICE CANNOT BE HANDLED WITH PRESSURE. ITS TEMPERATURE IS -174 DEG. FAHR.

The illustration above shows ten experiments which can be carried out with the ice-like carbon dioxide.

"Dry ice" has a temperature of approximately 174 degrees below zero Fahrenheit; it evaporates, leaving no residue.

ICE cream kept frozen with "dry ice" or solidified carbon dioxide gas can now be obtained in most of the larger cities. The usual method of packaging ice cream in this manner is with the aid of cardboard boxes containing the ice cream and the lump carbon dioxide. The snow-like carbon dioxide has a temperature of about 174 degrees below zero Fahrenheit, and maintains the surrounding air very cold. The "dry ice" evaporates so that eventually nothing is left, but as it does not contain water, not the slightest bit of moisture remains behind. The dry ice goes up in gas.

But after enjoying the ice cream, why not enjoy performing the simple experiments given here? They are very simple to perform and vividly show the properties of this curious substance.

Compared with this dry ice, or solid carbon dioxide gas, ice water is so hot that it will cause the former to gasify! Drop a lump of "dry ice" into water and watch the bubbles of gas given off. If you try this experiment in a room free from draughts, you can hold a lighted match over the glass of bubbling water and the match will be extinguished, because of the fact that the gas which is being released from the dry ice acts as a blanket and smothers the flame, keeping the oxygen of the air out. A drop of lime water placed on a sheet of glass and the sheet inverted over the tumbler, will turn white because calcium carbonate, which is chemically the same as marble, will be formed.

If a tumbler of "dry ice" is left exposed to the air, the walls of the glass will become so cold that the water vapor in the air will condense out on the sides of the glass and freeze there, forming a frost-like appearance.

A drop or two of mercury in a test tube can be frozen with this solidified carbon dioxide gas or dry ice. If a large enough quantity is taken, and a metal rod thrust through the mercury and allowed to freeze into the mass of mercury, a mercury hammer will result which will enable the experimenter to drive nails with frozen mercury.

The gas of which dry ice is composed is heavier than air and if a glass tumbler containing the ice is poured over on a burning candle, the candle will go out, for the carbon dioxide gas in the tumbler smothers the flame. You cannot see the gas pour out of the tumbler, for the gas is invisible.

A piece of dry ice placed in a bottle which is then corked will soon build up enough pressure within the bottle, due to the solid evaporating, so that the cork will be blown out.

A small flower immersed in crushed dry ice for five or ten minutes will become so cold that the liquid portion of the flower will become frozen, and if the flower be knocked on the table *it will break into pieces like it was made of glass.* Use a quantity of the ice enough to more than completely cover the flower in this experiment.

A fountain is easily made from a bottle, a length of rubber and a short piece of glass tubing which can be taken from a medicine dropper.

Do not handle dry ice with the hands for any length of time. It will abstract heat from the hand so fast that a sore will be formed similar to that obtained when the hand is burned by applying heat too fast to it.

Other experiments will readily occur to the experimenter.

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Monobasic Acids

By DR. ERNEST BADE, PH. D.

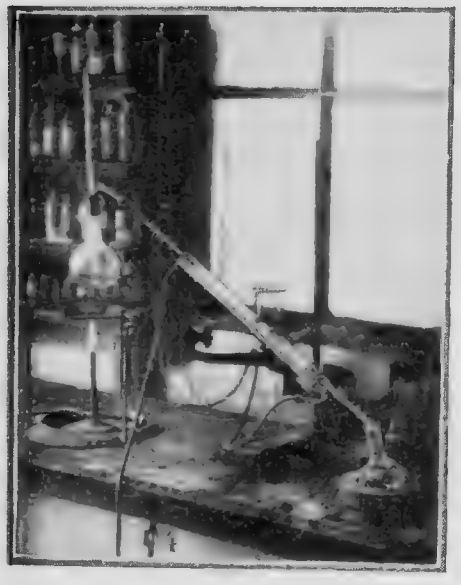
The Amateur Chemist Will Find Much of Interest in Performing the Experiments With This Large Group of Acids

THE organic acids make up a large group or series and, since many of the higher members occur in natural animal and vegetable oils, they are often called the fatty acids. They are all colorless liquids or solids, the simpler types possessing a sour taste and a pungent smell. This is absent in the higher and more complex forms. Combined with bases, they form salts. Then, too, the lower types are more soluble and have a greater acid strength than the higher forms.

The above photograph shows how the glycerine is dehydrated in a porcelain dish over a small flame. About 35 c.c. of this substance is used in the experiment.

The simplest of these acids is formic acid, which has a boiling point almost the same as that of water. It is found on the gland hairs of the stinging nettle. When the leaf is touched, the fine hairs enter the skin and discharge the acid, which quickly raises blisters. Among the animals, the insects such as bees and ants give off this acid. To prevent irritation and reduce the swelling, a mild alkali such as very dilute ammonia water or a solution of washing or baking soda is applied with a piece of absorbent cotton. This neutralizes the acid.

There are various ways in which formic acid may be made in the laboratory. The simplest uses glycerine and oxalic acid.



The water-free glycerine is placed in a flask and oxalic acid crystals are added. The mixture is distilled, taking care to watch the thermometer.

Place about 35 c.c. of glycerine in a porcelain dish and heat to a temperature of 175 degrees C. for an hour or two. Keep the temperature as constant as possible by inserting a thermometer and watching the mercury column. This dehydrates the glycerine.

The dry glycerine is now poured into a 250 c.c. flask and 40 grams of oxalic acid are added. Arrange the flask for distillation and insert a thermometer in such a way that the bulb is below the surface of the liquid. Heat gently, and keep the temperature between 100 and 120 degrees C. When no more liquid comes over, cool the flask and add 35 grams of oxalic acid and distill again. Several portions of oxalic acid may thus be used to obtain formic acid of about 50 per cent strength. The decomposition of the oxalic acid takes place at a temperature of 105 to 110 degrees C., carbon dioxide and water being given off, glycerine monoformiate being formed. The latter hydrolyses into glycerine and formic acid. In this way a small quantity of glycerine can change a large quantity of oxalic acid, before it is exhausted.

Redistill the dilute distillate of formic acid, collecting the fraction coming over at the temperature of 90 to 108 degrees C.

Acetic acid is next in the series and, since it is so very common, being found in vinegar, little need be said. The concentrated acid known as glacial acetic acid is obtained as one of the products in the destructive distillation of wood. Tar, an aqueous distillate and gas are formed. The distillate is neutralized with lime, the acetate of lime thus formed is gently heated and dried, after which it is distilled with hydrochloric acid and, after further treatments, for now it is only about 50 per cent strong, it is distilled a second time and the pure glacial acetic acid is obtained. It may be made from any other vinegar also.

A small portion of acetic acid is solidified in a test tube in which a thermometer has been placed. The test tube is surrounded by a freezing mixture. The photograph above shows the arrangement of the apparatus used

Acetic acid is easily prepared from sodium acetate which has been fused to make it anhydrous. This must be quickly powdered since it absorbs moisture from the air. Place about 30 grams in a 150 c.c. flask, cool the flask under running water and very slowly, small portions at a time, add 18 c.c. of concentrated sulphuric acid through a funnel, keeping the flask cool under the tap. Then distill the mass. When this has been done, redistill the acid and by means of a thermometer kept near the level of the exit tube of the vapor, the fraction distilling between 117 and 120 degrees C. is collected.

The butyric acid is separated from the mother liquid by means of a separatory funnel and placed in a distilling flask.

Place about 5 c.c. in a dry test tube and place the tube in ice water or a freezing mixture and insert a thermometer into the acid. Lightly scratch the tube. The acid should solidify.

(*Continued on page* 82)

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The AIR We Breathe

By Dr. WILLIAM LEMKIN, Ph. D.

(Concluded from March Number)

A strip of paper moistened with cobalt chloride when thoroughly dried will be almost colorless. When exposed to moist air, it turns pink.

Water Vapor and Humidity

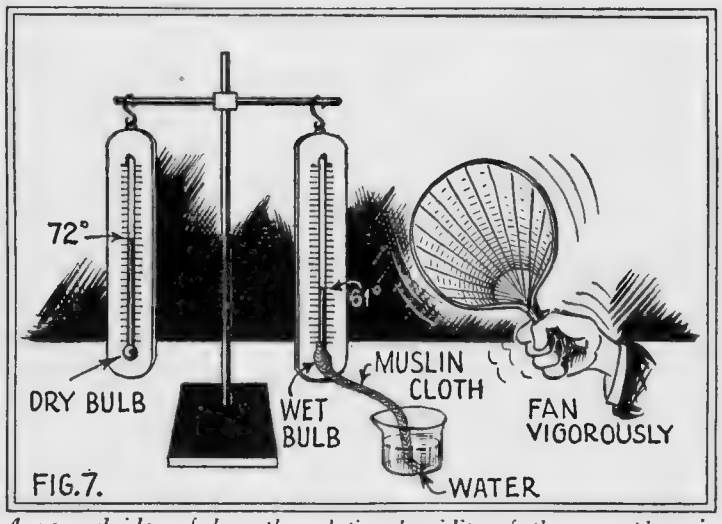
THE water vapor or moisture present in the air is one of the most important of its component gases. Small though its amount is, it is vitally necessary for all plant and animal life. We all know how often we complain of humidity. The amount of water vapor which a given volume of air can normally hold is determined by the temperature. The hotter the air, the more moisture it can hold without precipitation. Humidity is a measure of the quantity of water vapor in the air. A relative humidity of fifty means that the air contains only 50 per cent or half of the moisture which it can hold at that temperature. A humidity between forty and seventy-five is comfortable; from seventy-five to one hundred the humidity is oppressive. At one hundred we reach the saturation point, and some form of precipitation results, either rain, snow, hail or dew.

To demonstrate the existence of moisture in the air, fill a wide-mouthed preserving jar with crushed ice or snow. Wipe the outside thoroughly dry. Suspend the jar in the room or out-of-doors. After a short time you will notice that the water vapor has condensed and settled on the outside of the jar in the form of drops. The more humid the day the more abundant will be this deposit of moisture.

If you can obtain some cobalt chloride you will be able to perform a simple and very striking test. Saturate a strip of paper with the solution, which is pale blue in color, and dry it thoroughly. When in this condition the paper shows almost no color. Expose it to the air out of doors; under moist conditions it turns pink.

Another test, of a semi-quantitative nature, may be tried, using calcium chloride. Weigh a small dish containing several grams of this salt and expose the dish to the air for two hours. Then weigh it again. The increase in weight is due to water absorbed from the air. This property possessed by certain substances, of acquiring water from the air, and even dissolving in that water, is called deliquescence.

A general notion of how the relative humidity of the atmosphere is measured may be obtained by employing the principle of the wet and dry bulb thermometers. Obtain two thermometers and first see that they both read alike. Suspend them side by side and fasten a piece of soft muslin cloth around the bulb of one of them, allowing the loose end of the cloth to hang down into a vessel filled with water. Fan the bulbs vigorously for a short time, then look at the reading of the wet bulb. Continue the fanning process until the mercury in the wet bulb thermometer ceases to go any lower. Then take the reading of both thermometers. A slight difference of say two or three degrees between the two instruments means a moist air. A large difference such as sixteen or eighteen degrees indicates a relatively dry air. The actual relative humidity depends, of course, also on the temperature of the air itself, and can be determined by noticing the difference and referring to a table of relative humidities at various temperatures.



A general idea of how the relative humidity of the atmosphere is measured may be obtained by employing the principle of the wet and dry bulb thermometer.

The Mysterious Ozone

IN addition to the four constituents already treated, the air may contain traces of other gases. The most interesting of these is ozone, (*Continued on page* 81)

To test for ozone, a special "ozone paper" is needed. When exposed to ozone, the test paper will turn blue.

When electric motors spark ozone is formed, and a test for this gas may be made with starch-iodide paper held in the vicinity of the electric device.

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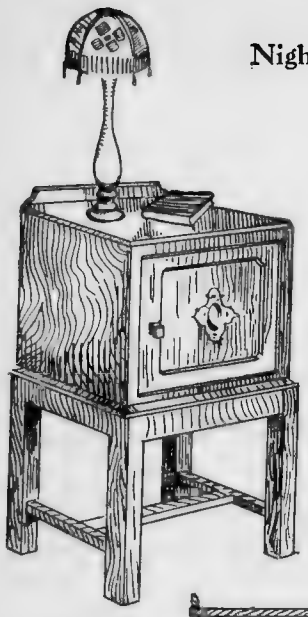
HOW TO MAKE IT

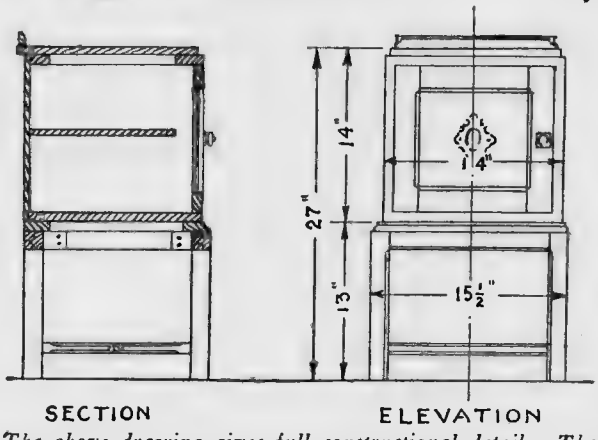
Time Saving Hints and Simple Repairs for the Amateur Mechanic and Wood Worker

Useful Articles for the Workshop and Home which can be Easily Constructed by Anyone

Night Table



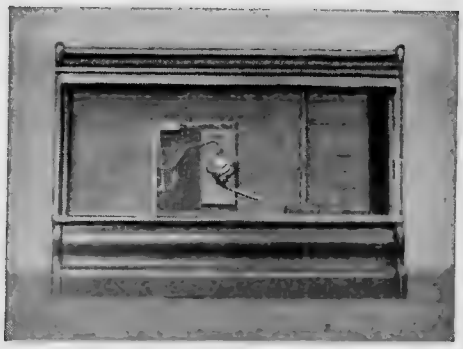
The above illustration shows the completed night table which forms a handy bedside table for the reading lamp, early morning breakfast tray, and the like.

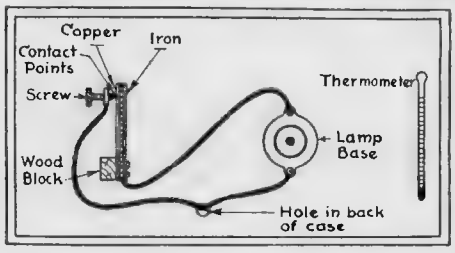


The above drawing gives full constructional details. The table is constructed in a manner similar to the washstand previously described.

A HANDY night table which forms a valuable bedside stand can be made according to the above illustration. The stand and top part are constructed separately and then screwed together. The cupboard portion has a door fitted with a ball catch and a free cut ornament is glued to the center of the panel. A sheet of plate glass should be used to protect the top of the stand. The article is finished to match the rest of the bedroom suite. A stand of this sort is usually included in a modern bedroom.—*J. E. Lovett.*

Laboratory Incubator



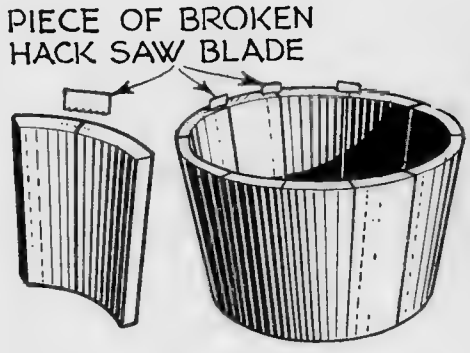


The above photograph shows the completed incubator. Details of the thermostat are also shown in the drawing.

AN inexpensive incubator for growing bacteria, yeasts and molds can be made from a section of a sectional bookcase. First make a thermostat from a piece of copper and iron about 5½ in. long and ¾ in. in width, soldered along the edges. Secure spark points from a Ford coil and solder one of them on the end of a point and fix so as to be adjustable with the other point soldered to the copper strip. It is convenient to fasten the apparatus to a board and placed within the incubator. Connect the thermostat in series with a 75-watt lamp as shown. By regulating the contact points carefully, it is possible to keep the temperature adjusted within one degree. A box can, of course, be used instead of the bookcase.—*E. K. Giffen.*

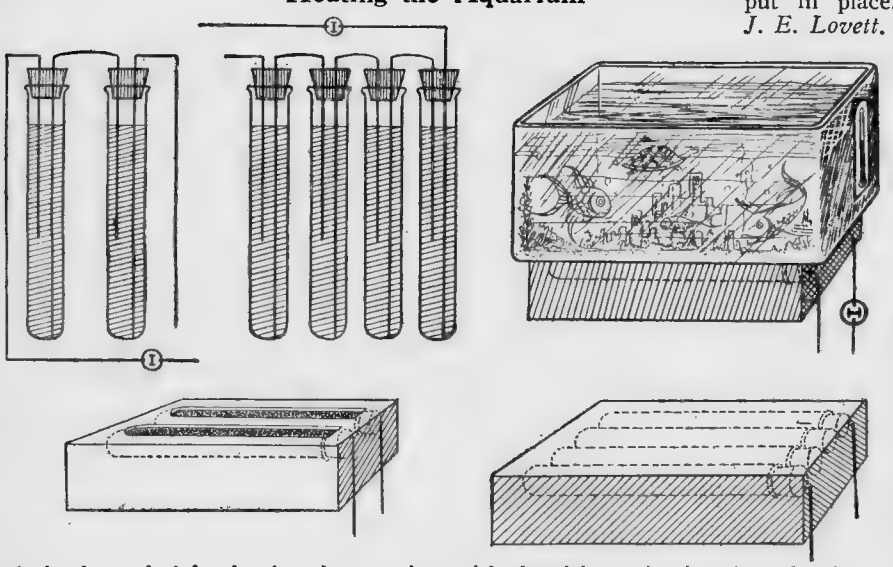
Wash Tub Repair

WHEN putting a bottom in a wash tub, pieces of hack-saw blade fixed as shown will keep the staves together until the hoop is put in place.—*J. E. Lovett.*



Pieces of hack-saw blade are driven in as shown to hold staves together.

Heating the Aquarium



A simple method for heating the aquarium with electricity which is safe and adjustable is illustrated above. A number of test tubes are filled with powdered graphite and connected to the lighting lines. By pushing the connecting wire in or drawing it partly out of the tube, the temperature can be closely regulated. When the proper adjustment has been found, the corks can be coated with sealing wax.

AN excellent method for heating the aquarium consists in using a number of test tubes filled with graphite as the heating unit. These are closed with a tightly fitting cork through which two holes have been bored. These holes allow for the insertion of two wires as illustrated. Two or more tubes are connected in series according to the heat required. The temperature is adjusted by moving the short wire partly in or out of the tube. Place the heating elements in a tin box and cover with sand. The top is put on the box and the heater placed under the aquarium. These units can also be used for other purposes, such as, heating glue and cultivating bacteria.—*Das Technik fur Alle.*

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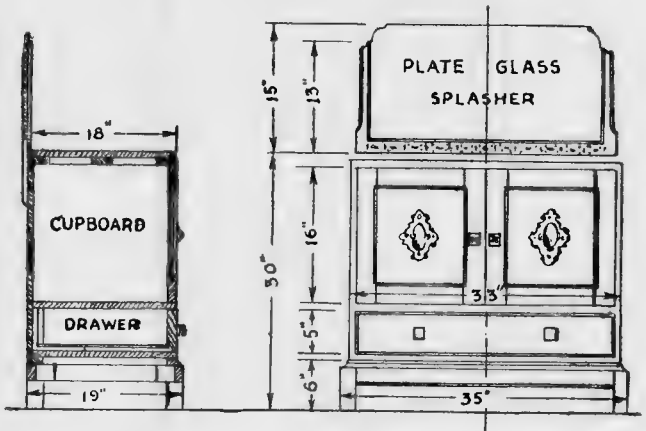
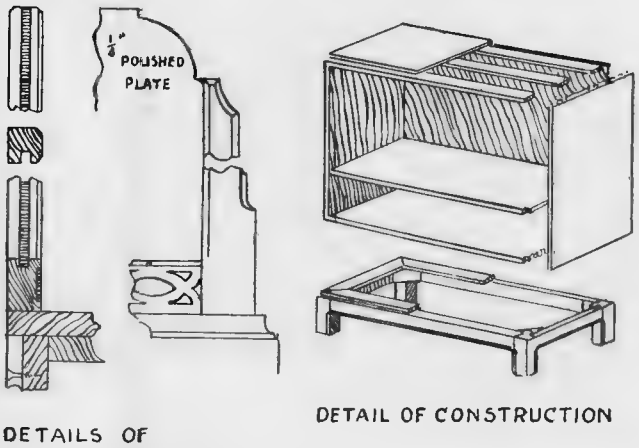
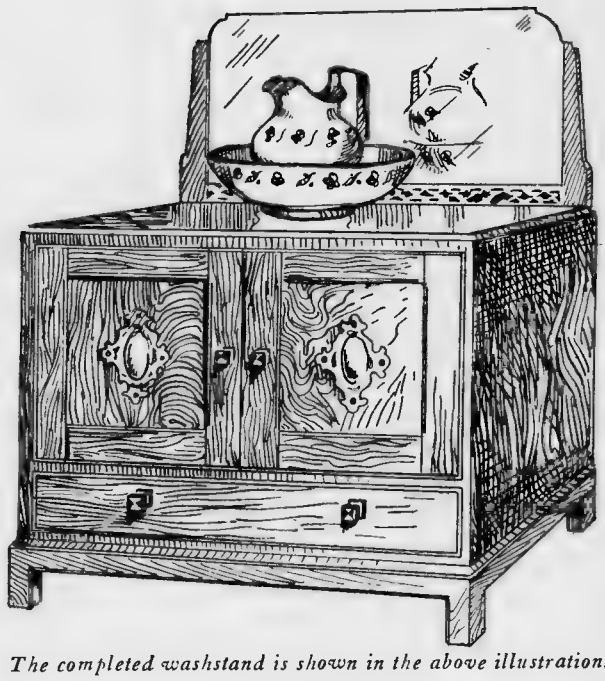
How to Build a Useful Washstand

Support for Bowl and Pitcher Add to Bedroom Conveniences





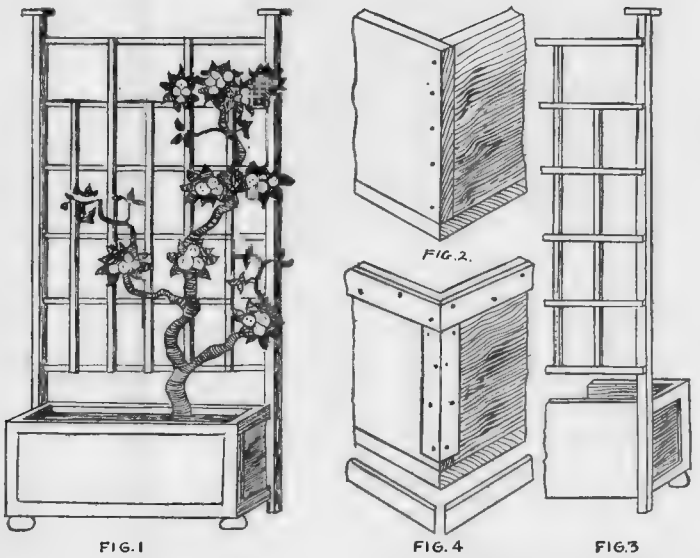
The above drawing shows how a washstand may be constructed.



The completed washstand is shown in the above illustration.

THE washstand shown here is designed as a companion piece to the wardrobe and dressing table previously described. The construction is similar and should not need a detailed description. The cupboard may be fitted with shelves or sliding trays and a long drawer is provided. A splasher of polished plate glass is fitted to the back. The top should be covered with plate glass, to protect the surface from scratches and moisture. If the piece is required for a dressing chest only, the splasher can be omitted but the back edging should be retained to prevent articles from slipping behind the chest. A pattern for the fret cut ornaments was given with the wardrobe design, but in this case it should be plotted into 3/16 in. squares. The little suite described in this and previous articles may seem simple and severe in design but it is intended to meet modern requirements in the modern home.—*J. E. Lovett.*

Flower Box *with* Trellis



In the above illustration Fig. 1 shows the flower box with trellis background. Figs. 2 and 4 give the details of the box, and Fig. 3 shows the trellis.

THE box shown in Fig. 1 measures roughly 2 feet long by 1 ft. wide by 9 in. deep, with the trellis background 4 ft. high, but boxes of almost any reasonable size can be made. Deal or hardwood may be used, the timbers being about 1 in. thick. The ends are nailed between the sides. The bottom, which should have a number of ¾-in. drainage holes bored in it, is nailed below. This method of construction is shown at Fig. 2. The trellis screen is formed with two uprights nailed to the back corners of the box. The uprights should be 4 ft. long, or longer, by 1¼ in. square. They are nailed in place with their bottom ends extending 2 in. below the bottom of the box, nails being driven through the uprights into the box, and through the corners of the box into the uprights. Caps about 2½ in. square by ½-in. thick are nailed to the top ends of the uprights, and the trellis is formed with ¾-in. by ½-in. battens. The horizontal battens are nailed to the uprights first, after which the upright battens are nailed to the horizontal, as shown at Fig. 3.

Ball or square feet, 2 in. high, should be fixed under the front of the box, and if a really neat finish is desired, slips should be nailed around the front and ends to imitate framing and to cover the end grain of the side and bottom. The slips should be about 1¼ in. wide by ¼-in. thick; the top and bottom slips are pinned on first, the corners being mitred as shown at Fig. 4, after which the corner slips are fixed.

The flower box with trellis background adds an additional artistic touch to the flower garden and can be readily carried indoors, where it may be kept during the winter.—*J. E. Lovett.*

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READERS FORUM—

SCIENCE AND INVENTION desires to hear from its readers. It solicits comments of general scientific interest, and will appreciate opinions on science subjects. The arguments pro and con will be aired on this page. This magazine also relishes criticisms, and will present them, whether caustic or not. So if you have anything to say, this is the place to say it. Please limit your letters to 200 words or less, and address your letters to Editor—The Readers Forum, c/o Science and Invention Magazine, 230 Fifth Avenue, New York City.

Baldness

Editor, SCIENCE AND INVENTION:

I have been an interested subscriber of your magazine, SCIENCE AND INVENTION for many years. Your article, "Can We Control Sex?" supplied the best of scientific information that can be had. Knowing this, I would like to suggest another subject.

My subject is "Baldness." Can it be prevented? Is it hereditary? Can hair be grown? If so, what is the correct method of obtaining hair growth?

I hold a position where I daily come in contact with thousands of people who express their interest on this subject. I feel that if you run articles concerning "Baldness" you will please thousands as well as do a great favor to your readers who are daily being misled by fake remedies.

I thought I would drop you this note merely as a suggestion, and I hope that if you decide to run such an article that you will choose "Baldness" as your next subject.

WM. DUNGENESS,,
Port Townsend, Wash.

(The subject of Baldness or Alopecia, as it is medically known, has been one about which text books have been written. Alopecia is usually popularly divided in two classes, the congenital and acquired. In other classifications Alopecia is divided into essential premature diseases and secondary symptomatic conditions.

In the first class we find the congenital and senile and also the premature forms. Congenital Alopecia is rare but when universal the prognosis is not as bad as in a partial affection. Senile Alopecia, as a result of old age, spreads on the scalp although hair may increase in growth in other parts of the body; such an increase does not take place on the scalp. Here, the whole process is primarily due to a lack of blood supply of the scalp incidental to the retrogressive nutritional changes of senility. It is plain that treatment here is of no avail and will not avert the loss of hair.

When such similar symptoms appear in younger persons who do not show evidences of degeneration resulting from old age, we get a premature Alopecia. Most therapeutic efforts are useless. Some people argue that the wearing of stiff-brimmed hats impeding the circulation in the scalp is the cause in this affection. Whether this is so or not depends entirely on the case and the physician usually recommends avoidance of injurious dietary habits to retard the progress of disease and some form of invigorating treatment to encourage active cell metabolism.

There is another form of Alopecia with a rather long Latin name attached to it which frequently follows diseases such as syphilis, diabetes, typhoid fever and any conditions which leave the system in a weakened state. Heredity also plays an important part here. While the loss of hair may occur all over the scalp, it is generally more marked in some spots than in others. This condition is curable but can be combatted only by long continued treatment which may last months or even years. If this condition occurs in early life and a hereditary taint of baldness runs in the family, the chances for successful treatment are less favorable.

Then there are so many other forms of Alopecia that it would be well to say a few words concerning them. One affects all of the hairy regions of the body. The prognosis is not unfavorable and local treatment consisting of invigorating baths in, let us say, salt water, and attention to general nutrition helps. There is Alopecia Simplex, which responds to ordinary treatment and Alopecia Areata, in which patches of baldness appear and which may remain for a period of from ten to fourteen years and then the hair may return spontaneously or it may never return to normalcy and so we see that the more we get into the condition the more involved it becomes. Verily, a loss of hair might be due to any one of many causes and removing the cause may or may not help in recovery. For example, it would be impossible to remove a hereditary predisposition toward hair loss. It is for this reason that so many systems can be advertised as being aids to the treatment of baldness. It must be obvious to the readers by this time that there are certain conditions of baldness which result in spontaneous recovery and in which ordinary tap water would help as well as "gifted" appliances, tonics, stimulants and what not.

There are many other conditions in which the most elaborate apparatus, regardless of how well designed it might be, would be of no avail. One cannot, consequently, recommend all of the various contraptions that have been designed for the treatment of baldness, nor could one say that under no circumstances were they of any value in alleviating the conditions.—EDITOR.)

IN THE MAY "AMAZING STORIES"

THE DIABOLICAL DRUG, by Clare Winger Harris. We hear a great deal in the press about the preservation and lengthening of life, for which all sorts of means are proposed. This topic is used as a basis for this engrossing story, which shows a very astonishing possible psychological effect of a drug of that kind. Written in the author's fascinating manner, the tale is well worth reading.

THE ENGLISH AT THE NORTH POLE, by Jules Verne, Part I. Combined with much general science Jules Verne tells us, in this story, and its sequel, much about the Polar regions, the formation of icebergs, and the movements of the ice. But in his own inimitable style, he never forgets to make his stories more absorbing by weaving into it, adventure, hardship and human interest.

THE GAS-WEED, by Stanton A. Coblentz. This story, by the author of "The Sunken World," depicts a strange invasion of the United States, where the attack spreads so that it threatens the world. It is not always an army or warfare of the most destructive kind that is most dangerous. It was a strange thing that menaced the world, and it was strangely difficult to combat. It is a story unusually rich in its scientific interest, and also excellent as a bit of fiction.

THE MOON STROLLERS, by J. Rogers Ullrich. Here is one of the best Moon stories which we have seen in a long time. It certainly is one of the most accurate ones scientifically. In it are shown the latest scientific discoveries. It shows what a Lunar expedition would require when it landed upon the Moon and how the explorers would get about on our satellite, which has practically no air, and whose temperature at all times is very near the absolute zero.

Mind-Reading and Dream-Recording Machine

Editor, SCIENCE AND INVENTION:

For the last few years I have been harboring plans for an invention but have never gone deep into it because of the quite terrific ridicule of my friends. For this reason, I cannot present you a very complete summary of my invention. Here it is:

It is, in short, an invention which will photograph one's dreams so that they may be flashed on a screen as easily as any other earthly subjects. This is accompanied by a vitophonic reproduction which records and presents (in a material form, audible to the human ear) all sounds which may be recorded mentally, in the course of the dream. The dream is materialized by a machine fitted with special reels and intensely delicate recording instruments, and a small contraption which fits over the sleeper's head. When the actual impressions of the dreams are recorded, along with the sound effects, they are sent through an elaborate arrangement of color materializing boxes, and a system of reproduction much like that used in television. After the film is developed in a darkened room, it may be screened just as any other moving picture, and the speaking effect is produced by an exact replica of the vitaphone. Such delicate things as mental impressions cannot be treated crudely. Thus, the machine would have to be tuned to fit the mind of each individual to use it. This invention is fitted with a dial watch (standard time) which is set at the moment of retiring. When the sleeper, now awake, turns the hands back to the time of setting, he rearranges the mechanism so that the watch covers an hour's movement in two minutes. When the second hand arrives at the point where the dream commenced, the machine instantly responds. If, because of the varying natures of dreams, the reproduction is not plain, it will have to be tuned until satisfactory.

I realize this would be expensive to construct.

FRANK C. ROSS, JR.
Kansas City, Mo.

(Such a machine as you describe would certainly be phenomenal. In fact such a mechanism would be the most remarkable invention that has ever been produced. The unfortunate part is that we see no way in which the work could conceivably be accomplished, at any expense. There is no proof that the energy in the form of thought waves ever passes out beyond the very matter in which it was developed. Thought transference has not been demonstrated and until we prove that it is perfectly possible to transmit thoughts or to demonstrate that they are

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THE EDITOR'S MAILBAG

energy in one form or another, we cannot build a machine for recording that energy. There is no indication that dreams can possibly be recorded except as far as their physical reaction on the human being can be recorded. In dreams the heart may beat faster. Muscle contractions might result but these effects when reproduced on the individual would not give rise to the same kind of a dream nor would they be the means of recalling the dreams to the person.

Some people talk in their sleep. Such talk could be recorded and in that way a connection between the dream and the talk might be established. We believe however, that your quest is hopeless even though the idea, while not new, is a commendable one. Many years ago the editor of this publication suggested a thought recorder made as in the diagram. Of course it was purely a figment of imagination.—EDITOR.)

Old Made Young

Editor, SCIENCE AND INVENTION:

What would it mean if it were possible to increase a person's life span almost indefinitely?

What would John D. Sr. pay for a couple of hundred years more? I don't have to tell you. I think I know how it can be done. There has been a lot said recently about how the glands control the workings of the whole body. These glands pour their mysterious fluids into the blood and their power is transmitted in this way.

It has also been said that there are certain cells that increase very rapidly in the blood of a young man, but hardly grow at all in the blood of an old man. Of course, you understand all about this, but you must consider all of the duties of the blood in figuring out whether my idea is worth experimenting with or not. I will not go into detail much, but will tell you all that is necessary.

My idea is to connect the blood stream of an old man with that of one or more young men, in such a way that the blood will flow from an artery or arteries of one or more young men into the blood stream of the old man, and from a vein back to the blood stream or streams of the young man or men. The blood flowing from the arteries of a young man naturally would be charged with oxygen, food and the necessary gland secretions for maintaining youth.

Of course, a man would not want to be hooked up like this all the time, and I do not think it would be necessary. A few hours a day should show surprising results. Any difficulty that would arise in carrying this out in a desirable manner could be easily overcome.

In a similar manner I think it would be possible to control size, disease, and even mix different kinds of animals so that their offspring would have characteristics from both kinds of animals. I would like to see these experiments carried out, but I would also like to be there and help skin it, as it were.

If it were so, I could do these experiments myself. I do not wish to see how much money I could get out of it. Therefore, I would listen to almost any proposition you would care to make.

The trouble with an idea of this kind is, if you show it to anyone, they can take it, and you cannot do anything about it, but it would hardly be fair.

LYNDON LYON,
Dolgeville, N. Y.

(The difficulty with your proposition is that you have started with the wrong premise. You assume that the transfusion of blood automatically makes a man young again; such is not the case. While it is true that a blood transfusion has aided many people as far as their general health is concerned, on not one occasion has a man become young again, after even several blood transfusions. The white blood cells in the new blood have managed to overcome the ravages of the disease and kill the bacteria in the blood stream, but the new blood has not restored cellular tissue. Therefore, the idea which you have advanced does not require additional experimentation. It has already been proven beyond a question of doubt, that the blood alone is not responsible for the condition of the body, and your suggestion can be put to no practical use.—EDITOR.)

Transplantation of Human Arm

Editor, SCIENCE AND INVENTION:

I have just read an article in SCIENCE AND INVENTION, by Joseph H. Kraus, entitled, "The Living Head." If this experiment was successful, why is it not possible to replace a lost arm? Either to rebuild an arm or graft on an arm and make it work. I do not write out of idle curiosity, but I lost my right arm years ago, and would like nothing better than to offer myself to anyone willing to try the experiment. It might be possible. Will you be good enough to tell me what you think?

R. J. BOLLON,
Gary, Indiana.

(Unfortunately, modern surgery has not reached the stage where the transplantation of an arm from one person to another can take place. It is true that in the insect world various experimenters have demonstrated the possibility of transplanting a head of one insect to the body of another. It is also true that eyes of fish have been transplanted and, according to the investigators, the fish could see after the operation. It is, however, difficult to say whether this "sight" was present or whether the fish registered the presence of food by means of some other sensory organ such as that of smell.

In the human being, history has recorded attempted operations on the transplantation of members of the body. But successfully, we have had to content ourselves with skin grafts and muscle flaps and here and there, a bone graft, but we do not believe that anyone has as yet been able to transplant any major member of the body. Eventually, we will reach that stage, but we will have to know a great more about surgery than we do today.

The man who is able to demonstrate surgically, that he can transplant an arm or a leg, will make himself worldly famous. There are many like yourself, that would willingly risk death in an effort to have a leg, an arm, an eye or a tooth transferred from another body to their own.—EDITOR.)

Disassociated Minds

Editor, SCIENCE AND INVENTION:

I have just read Mernos, by Henry James, in the February issue of AMAZING STORIES. I think that it is easily the best story of its type that I have read in AMAZING STORIES.

I wonder if you could send me information concerning the possible independence of the mind from the body. Would it be possible, by means of concentration, to travel forth from your physical body as an astral being? How much concentration would this require if it were possible? Would it require any special type of mind? Have any experiments been made in the past along this line?

DUNCAN C. LEE.
Washington, D. C.

(Such a thing as the mind leaving the physical body is not known to science. In thought alone the mind can travel, but so far as its disassociation with the body is concerned, the mind itself always remains with the body. To make this statement a little more specific, we will cite a few examples.

It is perfectly conceivable for man to think of events taking place on one of our sister planets. One can even imagine an occurrence taking place on a planet outside of our own solar system. We can imagine what the Fourth Dimension is like, of what the interior of the earth is composed, and even come still closer to home by imagining what is going on behind the closed doors of a room. But it is impossible for us by either transfer or otherwise to disassociate the mind from the body and cause the mind to travel into the interior of that room and correctly describe in detail what is going on in that room.

Under test conditions in this country, we have been unable to see even a superficial demonstration with the individual trying to describe a simple event in an adjacent room.—EDITOR.)

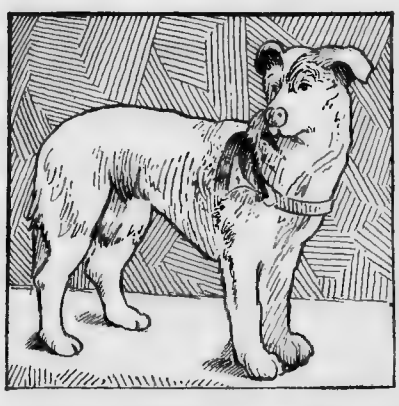
Talking Dogs

Editor, SCIENCE AND INVENTION:

I read an article in a Spanish magazine which told of talking dogs. The writer of the article seems quite positive of the truth of it.

I don't believe a dog is capable of uttering any intelligible words, although that is what the article states. What do you think about it?

GILBERT QUINTANILLA,
Monterray, N. S., Mexico.



(Dogs that speak are known on the American and foreign stages. Some years ago a German actress brought two dogs to this country and if memory serves us correctly, they were able to utter a series of distinct words easily understood by any in the audience. Of course, it is true that there is a big difference between uttering words and carrying on a conversation or talking in intelligent sentences. What generally happens is that the dog is asked tao mention one word and by a series of articulated barks is able to produce a sound somewhat similar to the word required.—EDITOR.)

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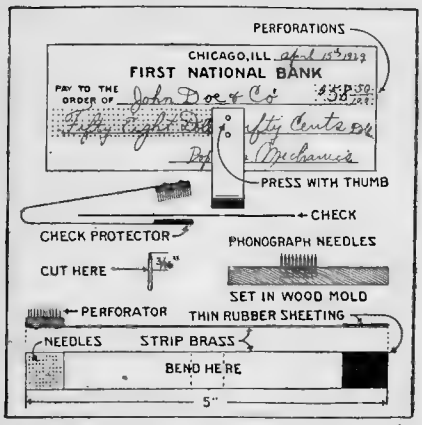
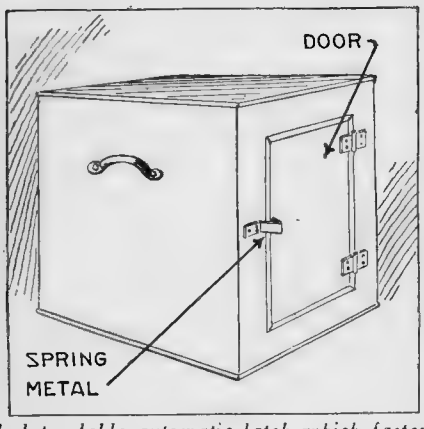
RINKLES, RECIPES *and* FORMULAS

Check Protector



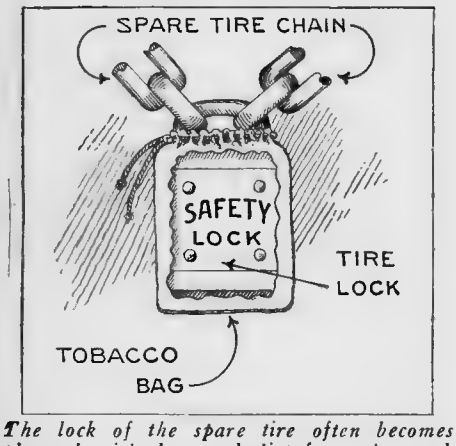
A pocket check protector can be made from a strip of spring brass, a few phonograph needles, a wide rubberband and a wooden mold. The needles are imbedded in lead and then fastened to the brass strip. Perforations are made by placing the needles over the place required and pressing down.
—H. R. Wallin.

A Door Latch



A dependable automatic latch which fastens the door when it is closed is shown above. It is best made from a strip of tin or other springy metal. A strip of brass could also be used when bent in the form shown.—
Leon J. Israilevich.

Lock Protector



The lock of the spare tire often becomes plugged with dust and dirt from the road. If a cloth tobacco bag is tied over the lock, the keyhole will be protected and will always be open and clear. This simple kink saves much annoyance and allows the lock to be readily opened at all times.—
R. B. Wailes.

Cleaning Large Bottles

Large bottles can be easily cleaned by dropping in a short length of small chain and then shaking vigorously. The chain is easy to remove from the water, being all in one piece.—*Contributed by Clifton Ask.*

Light at the Fuse Box

Most of us are bothered by lack of light when hunting for burnt-out fuses. This can be remedied by replacing one fuse with an ordinary electric light, preferably with a shade. This is especially helpful at night.—*Contributed by John Buddhue, Reporter No. 28724.*

When Blacking Stoves

Before blacking a stove, try greasing it with fresh grease, you will find that this will prevent the stove from rusting. Add a pinch of brown sugar to the blacking just before applying. This causes it to stick, and it polishes much easier and with half the usual rubbing. —*Contributed by Juliette Frazier.*

Substitute Wick for Pocket Lighter

It is sometimes necessary to have a new wick for a pocket cigar lighter when one is not easily available. Such a wick may be easily made by cutting a piece off an old round shoe string, and substituting this for the burned out wick.—*Contributed by Kenneth Gray.*

Ink Eradicator

A very quick, clean and effective way to remove ink from paper, cardboard, etc. is to apply Zonite to it. This disinfectant makes a very satisfactory job, Care should be taken not to use it on colored material as it will destroy the dye.—*Contributed by Leslie Carpenter.*

Cleaning Mercury

I am an ardent reader of the SCIENCE AND INVENTION magazine, and consider it the best of all science publications. I am much interested in scientific things.

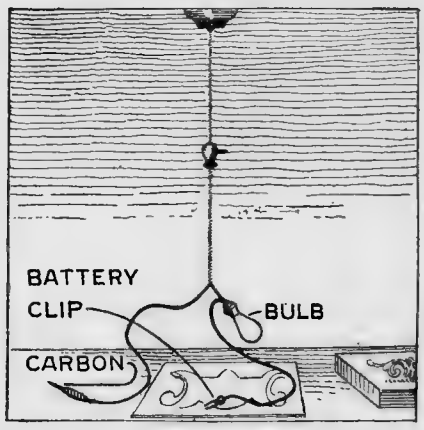
I am a senior in high school and had physics last year and am taking chemistry now, which I enjoy very much. I read in your magazine of an article on how to build a barometer. I have just completed mine and it works very nicely.

I have found out a new way (I think so) to clean mercury, as the mercury I used was very dirty and dusty, having been used before for the same purpose and lying in the open for about a year my instructor in chemistry said.

I put the mercury in a sauce dish and ran through it strips of scratch pad paper about one and one-half inches wide. After repeating this, with a new piece of paper every time, for a little while the mercury became very clear and as shiny as the new mercury. It was so clear I could see myself in it.

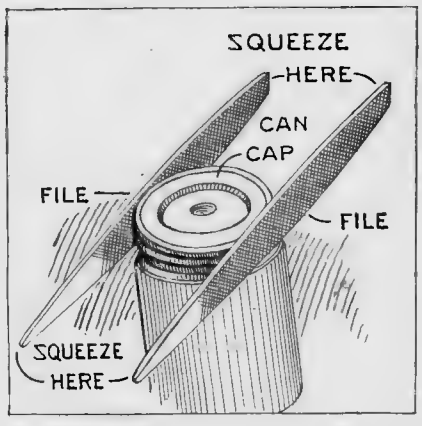
Thanking you for your time, etc.—*Contributed by Harold Epple.*

Electric Engraver



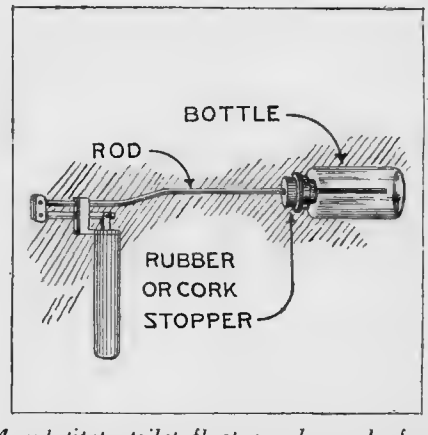
An electric engraver can be made from a carbon pencil, a length of wire and a battery clip. The above drawing shows how these materials are assembled. To use, fasten the clip on the metal and trace the design or letter with the carbon, lightly touching the metal.—E. C. Frye.

Substitute Wrench



A handy substitute for a wrench is shown above. Two mill files are placed on either side and the ends squeezed together, gripping the cap tightly.—Frank R. Moore. Reporter Number 1993.

Toilet Float



A substitute toilet float can be made from a glass bottle and a rubber or cork stopper. A hole is bored through the stopper, the float supporting rod forced through the hole, and the stopper placed in the bottle. If the rubber stopper rots, it is a simple matter to install a new one.—J. C. Phillips.

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An Improved Scanning System

New Disc is Outstanding Feature

ALL those interested in the art of television know that some method of scanning must be employed at the transmitter and receiver. A recent and interesting invention is applicable to both the scanning disc and to the picture reproducing device, and is described in a patent recently issued to the Westinghouse Elec. and Mfg. Company.

Rotating Discs

HERETOFORE, a disc having a spiral of holes or a circular or spiral row of lenses has been employed. Since this disc is rotated at a high speed, large centrifugal stresses were introduced. The lenses used in some types of scanning discs differed greatly in density from the disc itself, and caused highly localized inertia forces. It is the object of the present invention to provide a disc, which will avoid the difficulties encountered when lenses are mounted in the moving disc.

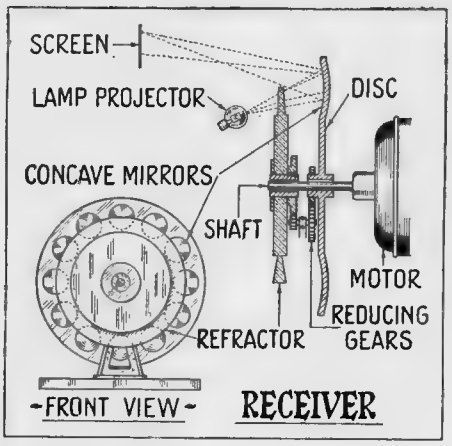
A New Disc

A FOCUSING device is added to the disc, so as to produce a substantially homogeneous structure. In the manufacture of the disc mentioned here, the depressions which are to be the concave mirrors, may be produced either by stamping or by grinding. These curvatures are shown exaggerated in the drawing for the purpose of clearness, but actually the change in the shape of the disc is so slight that it produces little weakening. After the depressions have been formed they are given a finer grinding. Preferably the mirrors are spherical but other forms of reflectors may be used. The disc can be made of stainless steel or plated with chromium and the entire surface, except the mirrors, given a coat of some non-reflecting substance, or, the disc may be made of dull metal and the mirrors plated alone with a reflecting metal.

A disc having spherical mirrors formed as described may be rotated at a high speed without breakage and also has the advantage that the mirrors will cause very little of the unbalancing of the disc which is caused by lenses. Consequently, vibration of the rotating parts which cause a blurring of the picture will be eliminated. It has the further advantage that the disc and focusing device constitute one body.

Transmitter

A SIMPLIFIED drawing of the transmitter appears upon this page. The shaft of the motor carries the disc and the first member of a train of reducing gears by means of which the refracting device may be driven at a slower speed than the disc itself. The refractor is of glass and includes a ring-like portion which has a prismatic cross-section, the angle of which varies progressively from point to point along the circumference. As a consequence of this variation, the glass tapers outwardly in one portion of the annulus. This outward taper diminishes progressively, until a point is reached where the faces of the glass are parallel. The variation of the angle continues and the margin at this part of the circumference tapers inwardly with a gradually increasing taper until the point where the outward taper begins is reached. At this point there is an abrupt change in the shape of the prism. At all other points throughout the ring-like portion, the change in shape is gradual. In operation the light which comes from the object is focused upon the concave mirror and reflected therefrom toward the refracting device. The light coming from the refractor falls on the cell, which has a small light opening, so that only a small portion of the object is correlated with the opening of the photo-electric cell at one time. As the disc revolves, the motion of the mirror causes the point in the object corresponding to the opening of the photo cell to trace a line in one direction. The image is shifted in front of the photo-cell by the action of the refracting device. The shift is progressive, the image being moved farther and farther in one direction, as the angle of the prism changes gradually; and is shifted abruptly in the other direction when the shoulder of the refractor passes the operative position.

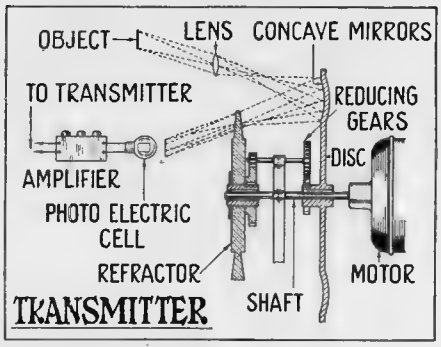


The receiver scanning system is illustrated above. The disc and refractor may be seen.

A Recent Television Invention

A ROTATING disc equipped with a row of concave reflectors made of the same material as the disc itself, has many advantages. This translating device for picture reproduction can be rotated at high speed, without the introduction of localized inertia forces, and permits the production of a clear image.

Better Images Possible



A simplified arrangement of the mode of scanning the object at the transmitting end is shown in the above drawing.

Receiver

IN the receiving system, a lamp projector similar to the crater lamp is used and casts a beam of light onto a refractor similar to that used at the transmitter. The mirror reflects this light onto a screen. The position of the point at which the reflected light strikes the screen depends upon the position of the refracting device and the position of the mirror which changes with the rotation of the disc. The illuminated point of light traces a line across the screen for each passage of a mirror. These lines progress as the refractor rotates and then move abruptly to their original positions, when the point is reached where the abrupt change takes place, in the shape of the refracting prism. At present, the gear ratio is such that the scanning disc rotates with four times the speed of the refracting device, but a much greater ratio can be used if necessary.

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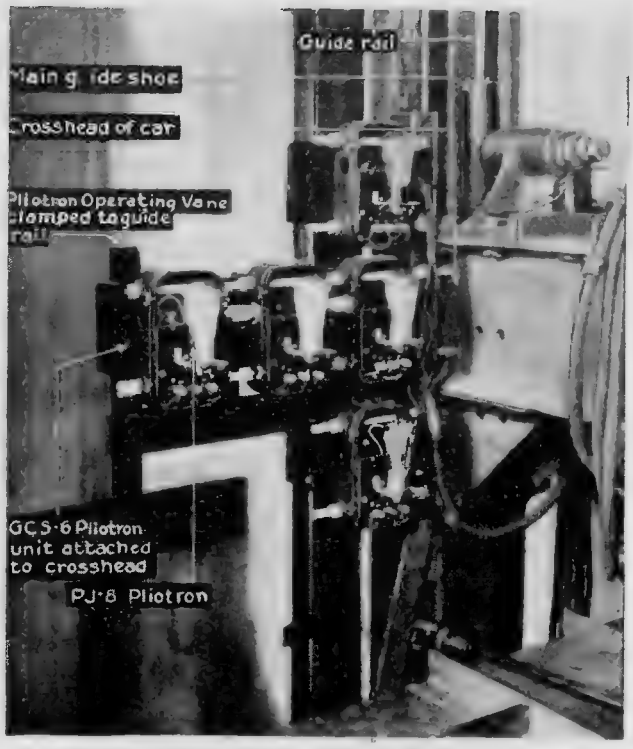
Lifts Leveled Automatically — *Vacuum Tubes in New Rôle*

Pliotron Leveling Units Bring Car to a Stop at the Floor Level Without Special Attention of the Operator in Charge.


Guide rail
Main guide shoe
Crosshead of car
Pliotron Operating Vane clamped to guide rail
GC 5-6 Pliotron unit attached to crosshead
PJ-8 Pliotron

The above photograph shows a bank of pliotron leveling units attached to an elevator car. The operating vane is clamped to the guide rail. The circuit oscillates at 200 k.c.

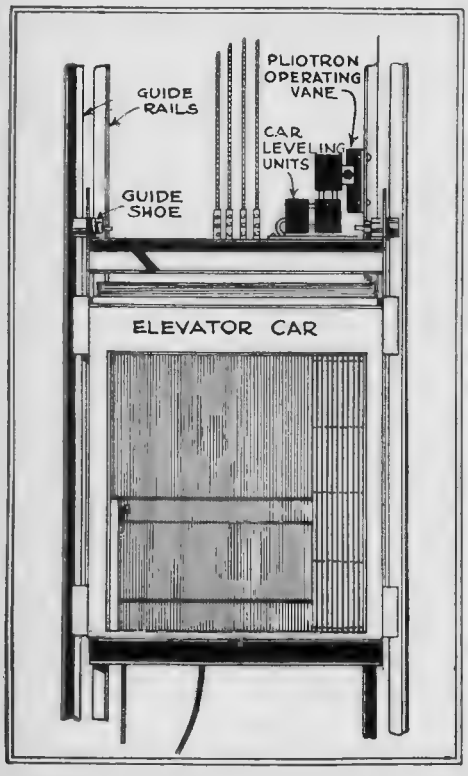
RADIO DEPARTMENT

Oscillating Circuits Find New Use

Radio Tubes Control Elevator

By
W. O. LUM
Industrial Control Engineering Dept., General Electric Co.

A PLIOTRON; *i.e.*, a kenotron composed of filament, grid and plate, will oscillate if coils are arranged in the grid and plate circuits in proximity to each other so that their fields couple and if the grid coil is suitably tuned with a capacitor across it. The frequency at which the circuit oscillates will be determined by the frequency of the tuned grid circuit. In standard leveling units this frequency is approximately 200 kilocycles.

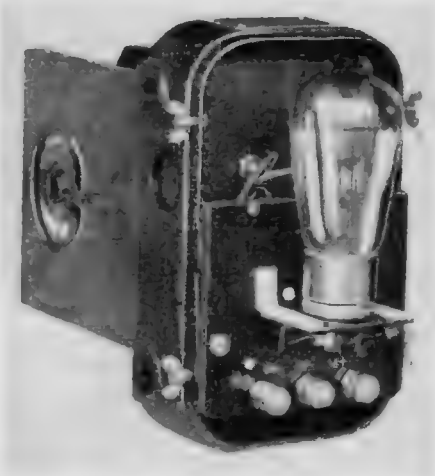


The above illustration shows the car leveling units and the operating vane which is interposed between the grid and plate coils of the oscillating circuit.

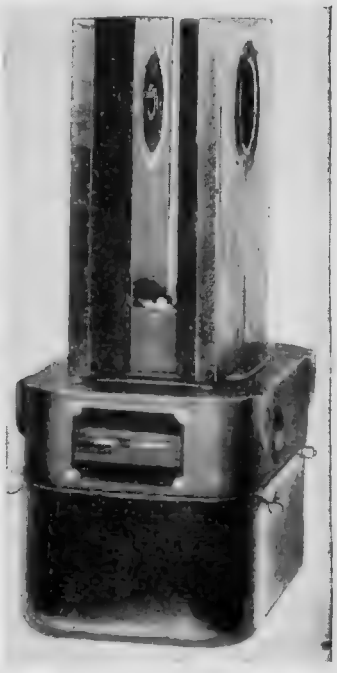
Oscillating Circuit

INASMUCH as the coupling between the grid and plate coil is essential for oscillation, breaking of this coupling will stop oscillation. When it is desired to break the coupling without contacts of any kind in any of the circuits involved, the grid and plate coils are arranged with a space between so that a metal vane inserted between the two coils prevents coupling of the fields and stops oscillation. In any oscillating circuit of this sort a very considerable change in plate cur-

(*Continued on page 71*)



One of the leveling units with case removed is shown here.



The grid and plate coils may be seen in the above photo.

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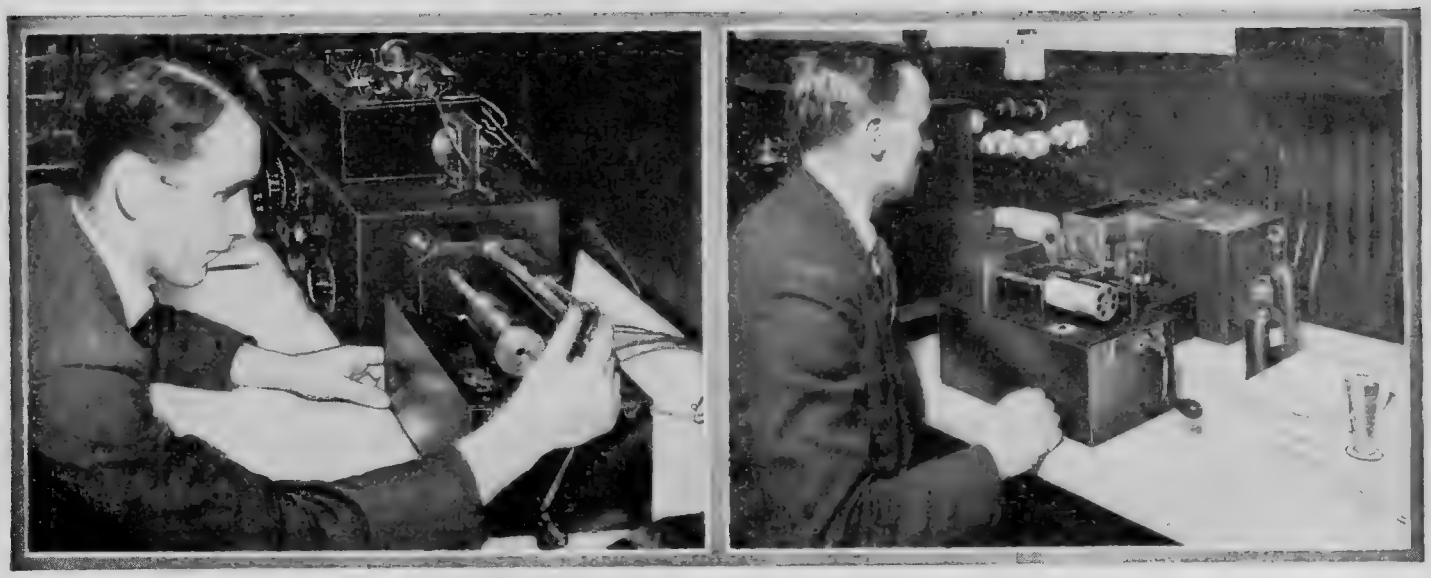
The "Fultograph" Broadcasts Pictures



The above photograph shows a picture broadcasting apparatus known as the "Fultograph," which was recently installed at 2LO, in London, England. A portrait of King George V was transmitted and a half-tone photograph in sepia was received. At the present time there are only about 25 picture receivers in use in England. Production is being speeded up and it is estimated that receiving apparatus for radio pictures ready for attachment to the set will cost about $90 to $100. The first picture was broadcast from station 5XX.

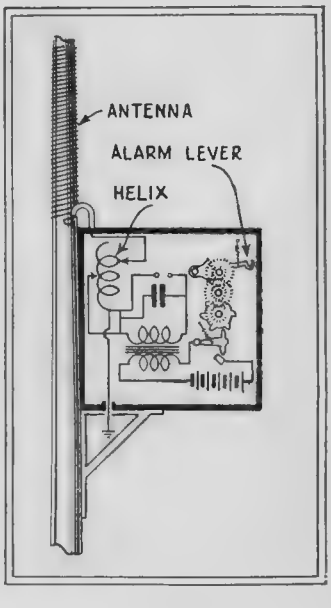
When the "Fultograph" apparatus was set in motion at 2LO, the signals were transferred to the seventy-six miles of land wire connecting the British Broadcasting Corp. Headquarters, at Savoy Hill, with Daventry, where radio station 5XX is located. The picture signals were sent out from this station on a wavelength of 1,562.5 meters, which is equivalent to 192 kilocycles. The receiving apparatus which was used to check the transmission is shown in the above photograph. The picture of the king being received appears on the cylinder.

THE RADIO FIRE ALARM

By S. R. WINTERS

At the right is a sectional view of the alarm showing placement of the antenna and apparatus enclosed in the alarm box.

At the left we see an alarm being sent by radio and its reception at a fire house with automatic gong being operated from the receiving set.



THE practical use of radio in sending fire, police, and burglar alarms is suggested in a patent recently issued to R. M. Keator. If radio were adopted as a means of signalling, the usual fire and police alarm call boxes would constitute a self-contained radio transmitting station and every post supporting an alarm system would be converted into an antenna or resonance wave coil by virtue of wire wound around it in a coil form as show. The alarm includes a pull lever and a train of gears which control the operation of a signal disc equipped with teeth. These teeth meet the necessary length to simulate the dot and dash of any desired code or signal. When rotating the signal disc, a switch is operated to close an electrical circuit including a source of current and the primary windings of a spark coil. Shunted across the secondary of the spark coil is a helix and a spark gap.

Tests show the necessity for a coiled antenna which should extend from the top of the pole to the box, but the coil section may be limited to a few feet, a straight wire leading down from the bottom of the coil to the helix. The period of the primary oscillating circuit, containing the spark gap, is closely tuned to the natural period of the antenna system. Police services in various cities and a marine fire company in New York City are already employing radio as a means of communication, but merely for the exchange of messages. Radio as an alarm would be an innovation whose practical details have to be worked out in accordance with this invention.

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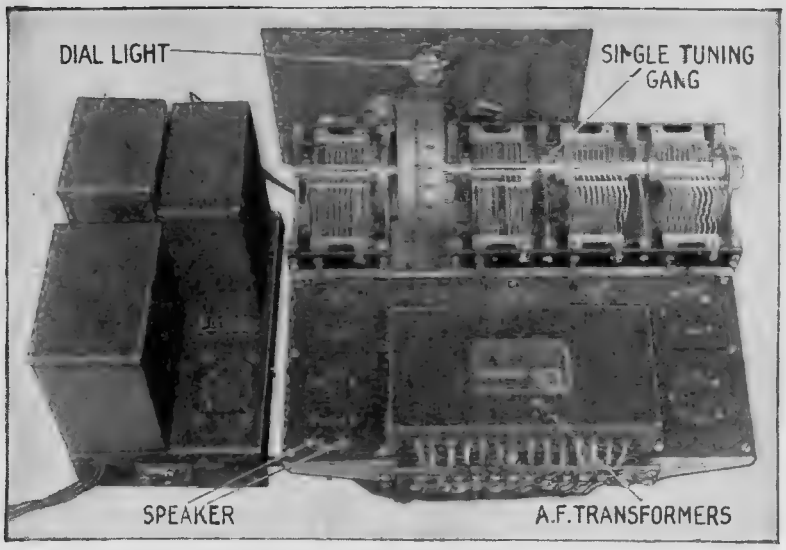
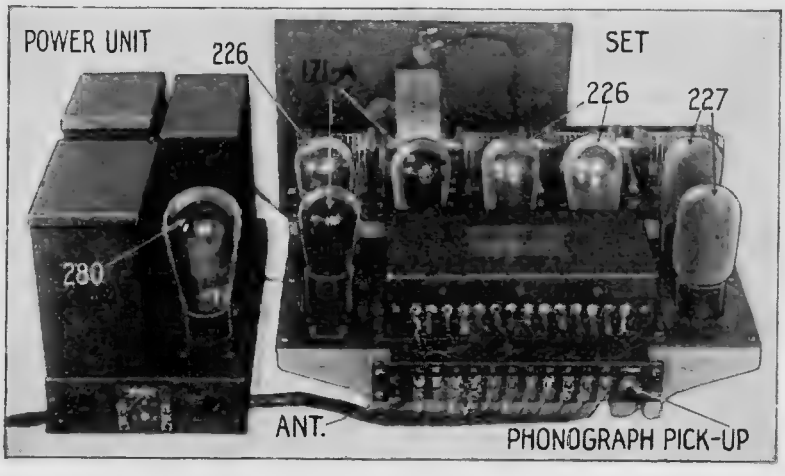
Seven-Tube Receiver Uses Single Dial Control and Push-Pull in the Last Audio Stage



A view of receiver showing single tuning gang appears above.

An A.C. Neutrodyne

AN all-electric receiver of the neutrodyne type which operates directly from an alternating current source of 110 volts is now available from a Chicago manufacturing company. The receiver in question shown in the photographs upon this page is housed in a polished walnut cabinet measuring 21 inches long, 12 inches deep and 10 inches high. Seven tubes are used, their type and position being as follows: in the first three radio frequency stages, 226-type tubes are used, in the detector and first audio, 227s, and in the last audio, which is a push-pull stage, two 171-As are employed. A single-gang tuning condenser is employed with an illuminated drum dial for selecting the stations. The front view of the receiver shows the placement of the other controls, namely, volume and compensating condenser. Two switches are also placed on the panel, one for turning the receiver on and off, and the other acts as a tone control. The coils are small, partially shielded and mounted directly below their respective tuning condensers in individual compartments.



The position of tubes may be seen here. A 280 rectifier is used in the power unit, which is on a chassis separate from the receiver.

Details of Construction

BOTH the receiver and power unit are assembled on separate cast aluminum chassis. All components are bolted thereto and held rigidly in place. A ten-foot extension board is provided for plugging into the light socket and another lead of the same length is furnished for making the ground connection. The antenna is connected to a binding post on the rear of the set. Here two tip jacks are also provided for a phonograph pick-up.

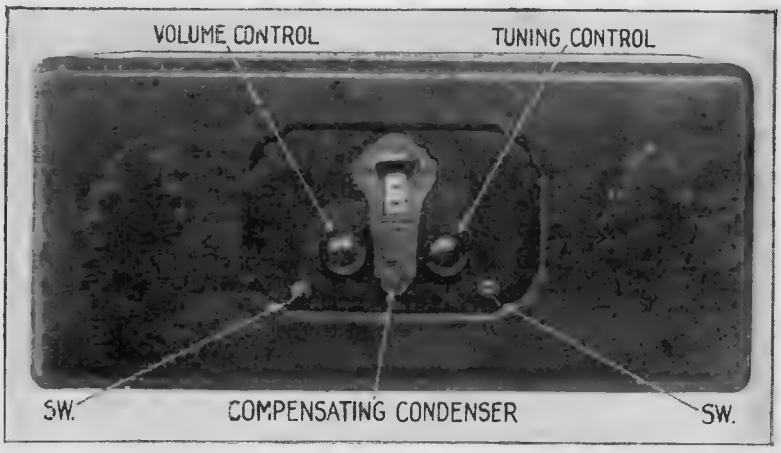
Power Unit

THE power unit, as may be seen in the photographs, is mounted upon a separate chassis and is entirely shielded. A 280-type tube is used for rectifying the alternating current and a well-filtered output with suitable voltage divider supplies the various "B" voltages to the receiver tubes. The filament current is obtained from windings on the power transformer which supplies the following a.c. voltages, 1.5 v., 2.3 v., 5 v.

A Few Words on the Operation of Set

IN operation, the receiver is quiet and free from any objectionable hum, due to a well-filtered power supply, the use of by-pass condensers and center-tapped resistors across the filament windings. When tested in New York City, the receiver was found to be selective even in this congested broadcasting area and was amply sensitive, picking up all local stations, even in the midst of tall, steel-frame buildings. The quality is good. With a dynamic speaker the receiver gave pleasing and faithful reproduction, partly made possible through the use of good audio-frequency transformers having a low frequency cut-off.

Much noise and tube hiss is eliminated in modern amplifiers by preventing the higher frequencies from being transferred. These amplifiers usually have a cut-off in the neighborhood of 5,000 cycles, passing a band 5 kc. wide. Set shown is designed for 110-volt, 60-cycle a.c. operation.



A front view is shown here. A single control is used for tuning with small knobs regulating the compensating condenser and volume control.

Name of manufacturer furnished upon request.

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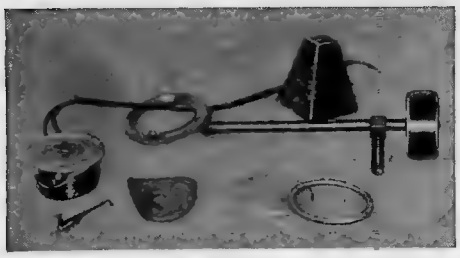
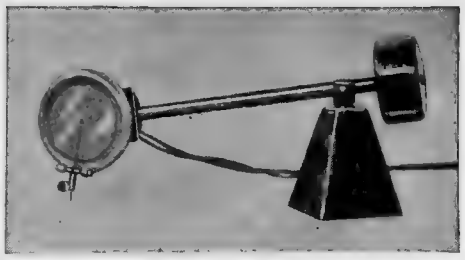


The above photograph shows a view of the pick-up with all parts ready for assembly.



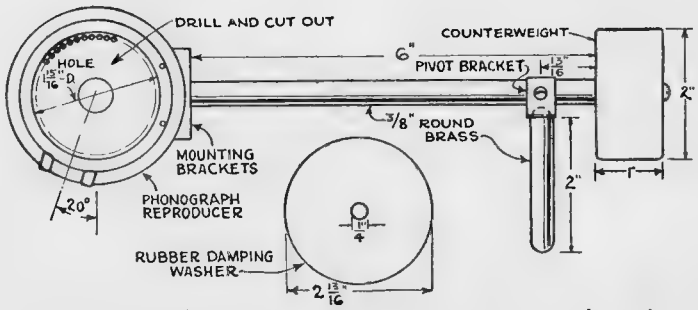
The completed pick-up is shown here. A coat of lacquer improves the appearance.

Constructing a Phonograph Pick-Up

An Old Pair of Headphones Furnish Raw Material for This Unit

By G. F. LAMPKIN

ONE who has an old pair of Baldwin receivers has the chief item of raw material necessary to make a phonograph pick-up. The receivers can be rescued from the obsolescence to which, no doubt, they have been relegated by the loudspeaker. One of the mica-diaphragm units can be rather simply converted to an electrical pick-up; and, when used in conjunction with the loudspeaker, will render a fuller measure of enjoyment from both radio set and phonograph.



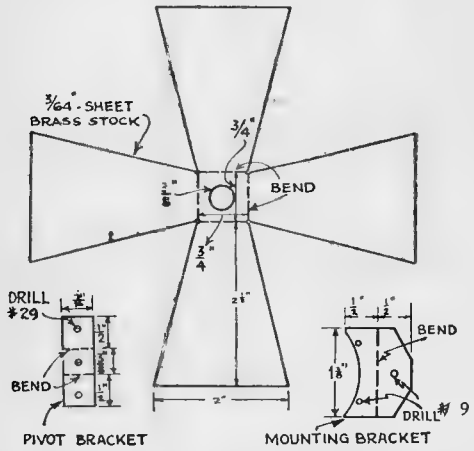
The above drawing shows how the phonograph reproducer is cut out to mount the receiver unit. A cold chisel is used to cut between the holes and the edges then filed.

Receiver

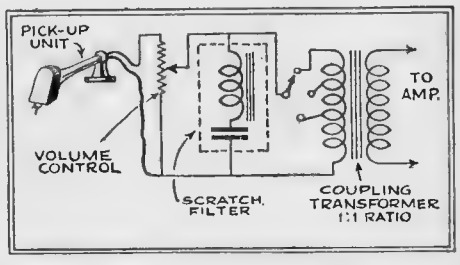
THE mica-diaphragm receiver embodies the balanced armature construction which is a part of the best magnetic pick-ups. The Baldwin type C receiver is of a size which just fits into a Columbia or similar phonograph reproducer—the latter is used to supply the needle arm, the pivot bearings, and the receiver mounting. Thus, except for cutting a few pieces of brass to size, the construction of the pick-up is but an assembly job. The quality of output is equal to, if not better than, that had from the best commercial jobs.

Mounting Headphone

THE photo shows the raw material necessary, the Baldwin type C headphone and a second-hand Columbia reproducer. Drawings show how the phonograph reproducer is drilled and cut out to mount the receiver unit. To disassemble the reproducer, the pivot screws on the needle arm are loosened and the clamping ring which holds the diaphragm is unscrewed. A couple of phonograph needles driven into undersize holes in a formica strip and spaced so as to fit the holes in the clamping ring, make a useful wrench. The needle arm is unscrewed from the reproducer diaphragm and the threaded end cut off and smoothed flush with the small shoulder. Two 6-32 tapped holes for mounting are made in the rear of the reproducer frame. The tedious part then comes in drilling holes around the circle, using a cold chisel carefully to cut between holes, and then filing the edges to make a smooth circle.



Details for the mounting bracket, pivot bracket and base shell are given here.



Added improvements lie in the use of a volume control, a scratch filter and a coupling transformer connected as shown.

Into this hole then is fitted the Baldwin unit. A rubber washer of dimensions shown is cut from an inner tube, and the hole in the original reproducer diaphragm is enlarged to 1/4" diameter. The reproducer diaphragm clamps outside the rubber washer and presses it against the receiver diaphragm. The clamping ring is then screwed down to hold the entire assembly. The end of the needle arm should be thoroughly tinned, and the piece put in position in its pivots. To reach and heat the soldered joint on the Baldwin receiver diaphragm, an auxiliary tip on the soldering iron may be made with a couple of turns of No. 14 copper wire around the point, with one end brought out about an inch and sharpened. Then both the end of the needle arm and the diaphragm joint can be heated

(*Continued on page 72*)

The materials used in making an electrical phonograph pick-up appear above. An old Columbia reproducer and Baldwin type C headphones are used. Except for cutting a few pieces of brass the construction is an assembly.

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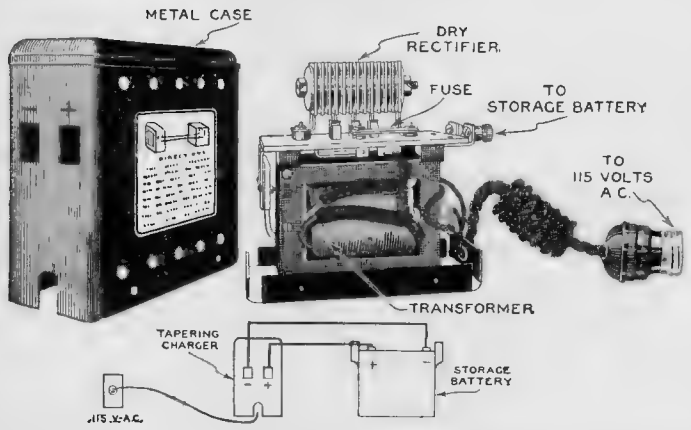
Recently Developed Apparatus and Accessories

Illustrated Here are Some of the Latest Radio Parts to be Made Available by the Manufacturers

NEW RADIO DEVICES

A Monthly Department

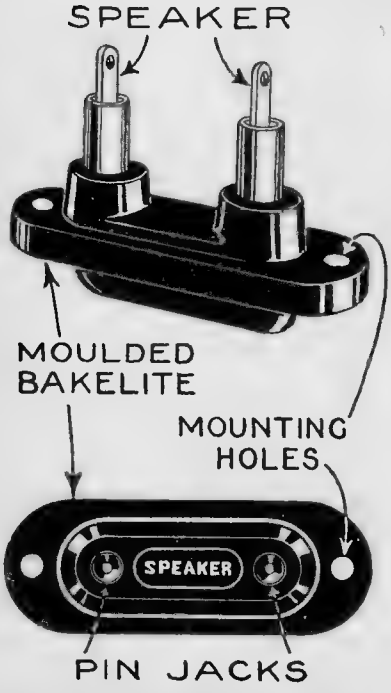
Tapering Charger



The new tapering charger for storage batteries has been illustrated above. The small drawing shows how it is used.

A TAPERING charger for storage batteries is now being made by a New York manufacturer. The charging rate varies with the conditions of the battery. When the battery is low, the rate is high, and *vice versa*. The maximum rate is 1 ampere. The charger can be left connected permanently without injuring the battery and requires no attention. The charger is perfectly dry and contains no tubes, acids or water, a dry rectifier being used. The rectifier is not affected by accidental overloading or line surges and has a life of approximately 5,000 hours. The instrument is easily installed, as only two connections to the battery are required.

Tip Jacks

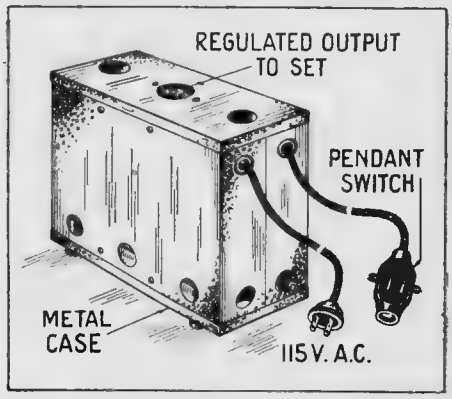


Above—the molded tip jacks.

THE molded tip jacks illustrated here are available from a Pennsylvania radio concern and have been designed for output terminals on radio receivers using chassis construction. The accessory consists of a molded brown bakelite plate, in which the tip jacks are placed. This plate is 2 in. long, 11/16 in. wide and the over-all depth is 1¼ in. to the end of the jacks. The spacing between the two tip jacks is approximately 1 in. On each side of the molded plate a hole is provided for fastening to the radio set. The particular tip jack illustrated here is for use with the loud speaker and is appropriately marked. However, a similar terminal can be obtained marked "phonograph" for use with radio-phonograph combination. This provides for connecting the phonograph pick-up to the audio amplifier of the radio receiver.

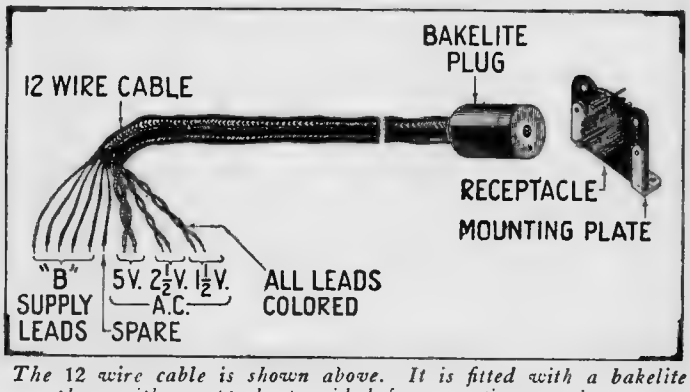
Voltage Regulator

WHEN the radio set is operated from the line, the voltage variations shorten the life of the tubes and affect loud speaker volume. The instrument shown is a voltage regulator, a product of a Massachusetts manufacturer, designed to supply a constant output of 110 volts, even though the input voltage may vary from 90 to 135 volts. It is designed to handle 60 watts under continuous load. The device is housed in a metal case with output receptacle on top. A cable is provided for connecting to the light socket and another with a switch for convenience in turning the set on and off.



A voltage regulator designed to maintain a constant output of 110 volts despite line variations is illustrated here.

Cable Connector Plug



The 12 wire cable is shown above. It is fitted with a bakelite plug, with receptacle provided for mounting on the set.

OWING to the great increase in the number of A.C. receivers, a Chicago manufacturer is now making a 12 wire cable connector plug. There are five leads for the "B" supply, one spare lead, and three twisted pairs for A.C. filament voltages. The A.C. leads are of heavy wire, in order to carry the current required by the tubes. On one end of the cable the leads terminate in a bakelite plug which fits into the plug terminals on the mounting plate, the latter being placed on the receiver chassis. The individual conductors in the cable are colored in accordance with R.M.A. standards. In addition, each conductor is also numbered to correspond to the numbers of the plug terminals on the mounting plate which are also colored, so as to eliminate any danger of a misconnection. A card showing the numbers and colors of leads is also provided.

Names of manufacturers supplied upon request.

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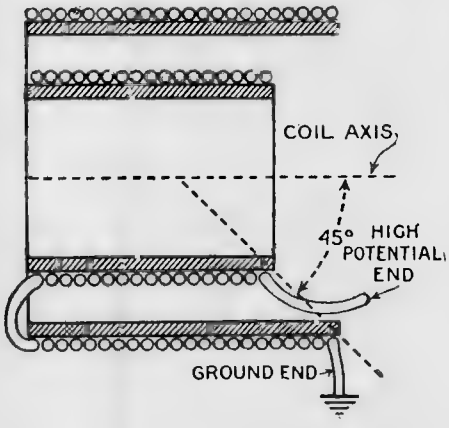
RADIO ORACLE

Shelf-Shielded Coil

(708) Can you give me any information concerning the design of a solenoid which will be self-shielded both electrostatically and magnetically?

A. 1. Certain forms of coils have been designed which have a small external field and are uncoupled, both magnetically and electrostatically. Among the forms employed are "D" windings, binocular coils and toroid windings. Even with these types, coupling between coils and the other apparatus is frequently experienced. A cross-sectional view of a self-shielded solenoid appears on this page. The coil comprises an inner and an



A cross-sectional view of a self-shielded solenoid coil is illustrated above. The coil comprises an inner and an outer winding.

outer form arranged in coaxial relation. The outer coil forms a magnetic and electrostatic shield for the inner coil. The two coil sections are connected together as shown, so that instantaneous currents traversing the coil sections are in opposite directions, or, in other words, so that opposite fluxes of different magnitudes are produced in the core of the inner coil. The outer coil and inner coil are joined at the same axial end, so that they may be wound in the same direction. The free end of the inner coil is the high potential end, and the free end of the outer coil is the ground end. The outer coil should preferably overlap the inner coil, so that a line joining their ends makes an angle of approximately 45 degrees with the axis of the coils. To produce the magnetic decoupling of the coil system, the ratio of the number of turns of the two coil sections must bear a definite relation to the ratio of the areas of the two coils. The product of the area and the number of turns of one section, should equal the product of the area and the number of turns of the other coil section. If this coil system is placed in a uniform magnetic field of variable intensity directed along the axis of the coils, the emf. (electro-motive-force or voltage) induced in the inner coil section is equal to the emf. induced in the outer coil section, because the induced emf. in a coil is a linear function of the number of turns and the total flux threading the coil. The resultant field at a distance is negligible, since the field produced by one coil neutralizes the field produced by the other coil. If the magnetic field is not parallel to the axis, the same condition exists. To produce the static shielding, the coil system is so constructed that the self-inductance of the outer coil section, is made equal to the mutual inductance between the two coils. When this

While there are many topics of interest to the radio enthusiast, which could be covered on this page, the editor finds it necessary to devote this space to items of timely interest.

condition exists, there is no potential drop along the outer coil, due to the high frequency currents flowing and the whole surface of this coil is substantially at one potential. Now, if this potential be made the ground potential, it will be seen that the coil system is electrostatically shielded. The outer coil may overhang the inner coil at each end, which slightly impairs the electrostatic shielding of the high potential end of the inner coil, but slightly improves the magnetic shielding. Generally, the ratio of areas of the outer to the inner coil may be from 5 to 1 to 1½ to 1, and for producing the greatest efficiency, this ratio should be about 2.1 and 2.2 for coils having ratios of 1.26, 1.58 and 2.1 respectively, of outer coil diameter to length. The inductance of the coil system is obtained mainly because the inner coil has in its core, a relatively intense magnetic field, which is only partly neutralized by the flux of the outer coil. A detailed description of the self-shielded coil will be found in U. S. Patent No. 1,608,560.

Electrolytes

(709) J. McMann, Buffalo, New York, writes:

Q. 1. Will you give me some information concerning electrolytes used in electrolytic rectifiers. What are the advantages of using ammonium phosphate and ammonium borate, instead of the usual borax used in the aluminum-lead type rectifier?

A. 1. Usually a saturated solution of commercial borax is employed in the home-made rectifier. This electrolyte is suitable, but if it is not chemically pure trouble may arise. Ammonium phosphate or ammonium borate dissolved in distilled water will give better results. The former is prepared by making a saturated solution of acid ammonium phosphate. The ammonium borate electrolyte is prepared in the same manner.

The ammonium phosphate electrolyte may be permitted to stand for a long period without harm. The ammonium borate, during an idle period, will increase its internal resistence which will cause a considerable drop in voltage. It may even be necessary to scrape the electrodes in order to have the rectifier function properly. The ammonium borate will react upon the lead, forming lead peroxide, which will fall to the bottom of the container. This trouble is not encountered with ammonium phosphate. Of course, the electrodes should be of the purest metal obtainable, so that no "local action" takes place.

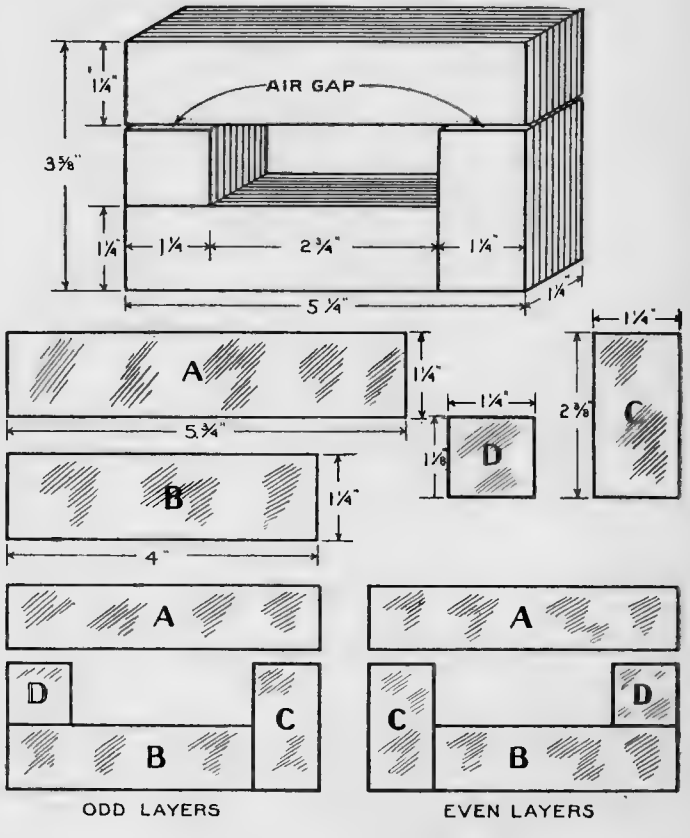
Choke Coil Core Assembly

(710) W. H. Johnson, Greensburg, Pa., writes:

Q. 1. Please give me a sketch showing the method of assembling the core for the 30 henry choke coil described in the February issue on Page 955.

A. 1. On this page you will find a drawing giving all details of the core assembly. Four different size laminations are used. They are shown here with their corresponding dimensions. These are combined to form the odd and even layers as shown. The core has four butt joints and a piece of ordinary writing paper is inserted at each of the joints to provide the necessary air gap. The coil should be wound on a wooden form bound with tape and slipped over the core-leg, which is built up with the longest laminations.

The laminations are made of No. 26 B & S gauge silicon steel. The coil consists of 7,800 turns of No. 26 enameled wire, wound with 150 turns per layer. The inductance is approximately 30 henries, while handling a current of 85 milliamperes. The direct current resistance of this "B" eliminator choke is 240 ohms.



The assembly of the core of the 30 henry choke coil, which was described in the February issue is shown here. Four different size laminations are combined to form the core.

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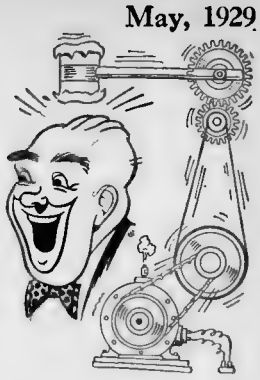
Scientific Humor



EXAMINATION QUESTIONS ANSWERED

What defies the law of gravitation?
Ans. A train window.
How many beans would it take to reach the moon?
Ans. One if it were big enough.
Does the moon affect the tide?
Ans. Yes and the un-tied.
What makes the world go round?
Ans. Home brew and nickel cigars.
Does deep breathing kill germs?
Ans. Germs don't breathe deep.
How is food kept in the stomach?
Ans. By bolting it down.—*Leslie F. Carpenter.*

AND A CUT-OUT

WILLIE: "Is she a hot number?"
NILLIE: "Is she! Say boy, when you're with that girl, a conscience won't do you any good. You need a thermostat!"—*Don Nabours.*

HARD ON STOMACH

EXCITED LADY: "My baby daughter swallowed a mirror."
CALM DOCTOR: "My what a gastronomical form of vanity."—*Leslie F. Carpenter.*

EFFICIENCY PLUS—

MRS. COHEN: "You say your boy Isaac is lazy?"
MRS. GOLDSTEIN: "He is so lazy he cuts his cigars in half so he won't have to draw the smoke so far.—*Leslie F. Carpenter.*

SOUNDS LIKE COW'S UNCLE

"Bob, were you in the army?"
"Yes, I was in the aviation division, and I should have had the record for altitude. I went up one night just after sunset—higher, and higher, and higher, I flew. At last the engine stalled, and I had to coast back to earth. On examination we found the propellor clogged with butter, churned when flying through the Milky Way."—*Miss Mahala Haseney.*

ONLY ONE FOOT RELATIVELY

First Prize—$3.00

It always makes me laugh—
So wonderful a treat—
To see a runner run a mile—
And only move two feet.
—*Ernest Culp.*

HOLLAND IN GREECE

PAT: "Are you Hungary?"
MIKE: "Yes, Siam."
PAT: "Den Russia to the table and I'll Fiji."
MIKE: "All right, I'll take Turkey, den Sweden my coffee and Denmark my bill."—*Fred H. Wise.*

ALL jokes published here are paid for at a rate of $1.00 each; $3.00 is paid for the best joke submitted each month.

Jokes must have a scientific strain and should be original.

Write each joke on a separate sheet of paper and add your name and address to each.

Unavailable material cannot be returned.

WE KNOW EVERY ANSWER

INQUIRER: "Oracle Editor, how can I make anti-freeze?"
O. E.: "Hide her woolen underwear!"—*Louise Krauss.*

STORM SWEPT

GUIDE: "On your left you see one of our greatest skyscrapers.
OLD LADY: "Oh, I'd just love to see it work."—*Adonis Hunt.*

HE SHOULD BE WINGED

JOHNNY BULL: "We have some very large birds in England. Why, once while I was standing in a zoological garden, I saw a man come in on an eagle."
YANKEE DUDE: "Brother, that's nothing. Once while standing in a ball park, I saw a player go out on a fly."—*Fred Erdos.*

MORE HEAD TO A MATCH

CHEMISTRY STUDE (reading laboratory direction): "It says here to 'line the iron spoon with asbestos paper, fill with red phosphorous and ignite."
CHEMISTRY PROF.: "Very well, what is your trouble?"
CHEMISTRY STUDE: "Well I can't find the bottle of ignite anywhere."—*H. R. James.*

TO CHECK WRITING

TOM: "What's the best check protector?"
HARRY: "A fountain pen that won't write!" —*Eula C. Hill.*

NOT EASILY DIGESTED

AL: "Where you gonna eat?"
PAL: "Let's eat up the street."
AL: "No, I don't like asphalt."—*S. H. Samuels.*

GILDA, WATCH YOUR LAURELS

NIT: "When I see Mabel walking, I remind myself of the telephone company.
WIT: "How zat?"
NIT: "All the lines are busy."—*Harry Horovitz.*

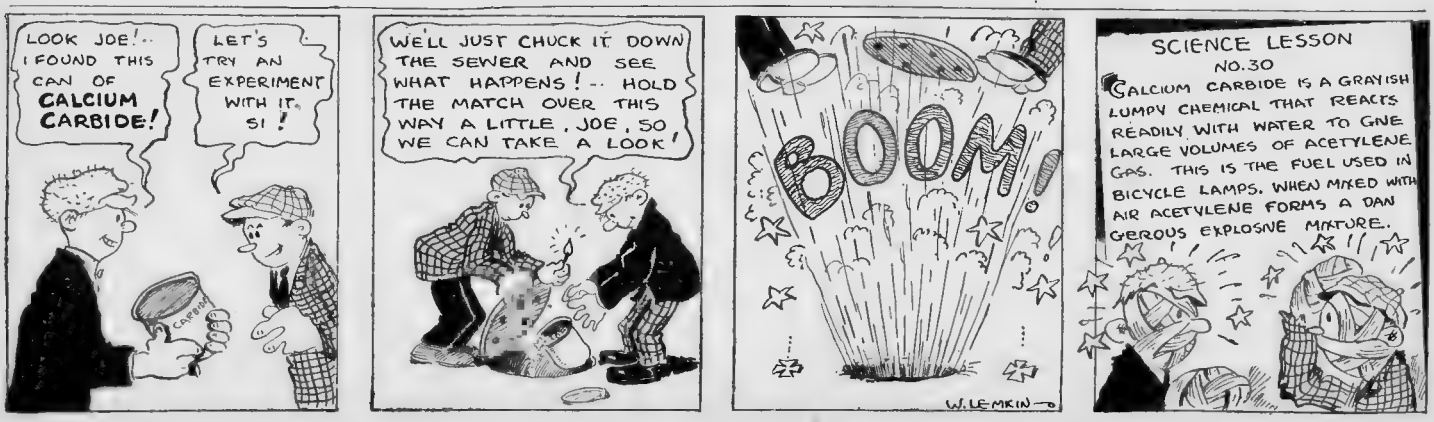
NO GRASS ON BUSY STREET

SCIENCE TEACHER: "Why did not nature give women whiskers?"
KID: "A chin that doesn't rest can't be shaved."—*Leslie F. Carpenter.*

IT WOULD WOOD

"If that big liner ever hit our launch, it would wreck it."
"So it would a pier."—*Gleason Pease.*

SCIENTY SIMON SCIENTIST


LOOK JOE! I FOUND THIS CAN OF CALCIUM CARBIDE!
LET'S TRY AN EXPERIMENT WITH IT, SI!
WE'LL JUST CHUCK IT DOWN THE SEWER AND SEE WHAT HAPPENS! HOLD THE MATCH OVER THIS WAY A LITTLE, JOE, SO WE CAN TAKE A LOOK!
BOOM!
W. LEMKIN
SCIENCE LESSON NO. 30
CALCIUM CARBIDE IS A GRAYISH LUMPY CHEMICAL THAT REACTS READILY WITH WATER TO GIVE LARGE VOLUMES OF ACETYLENE GAS. THIS IS THE FUEL USED IN BICYCLE LAMPS. WHEN MIXED WITH AIR ACETYLENE FORMS A DANGEROUS EXPLOSIVE MIXTURE.

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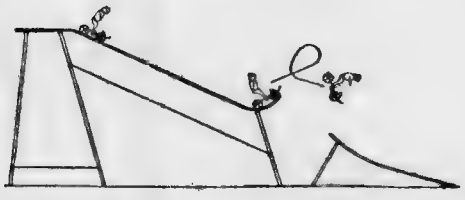
LATEST PATENTS

Somersaulting Toy

No. 1,695,310, issued to Philipp Wustendorfer. The illustration below shows a mechanical toy, comprising an inclined interrupted track or runway and a toy figure designed for sliding down this incline. In rushing down the runway, the toy is suddenly halted at the break in the track and is then catapulted by its own momentum across the track interruption. A trigger-controlled power device and a release member are arranged on the main runway section. The toy operates the release lever and executes a complete backward somersault during its passage from the main section of the runway to the run-out section. The power device is the same as is used in the construction of mouse traps. The wheels of the toy fit into guide grooves for the complete length of the trap. The released power member folds flat against the under face of the platform and for again setting the device for a new operation, it is merely swung back against the tensioned end position, and retained in place by the trigger. This toy does not require the use of a special actuating mechanism and will give the child a demonstration of a free loop-the-loop.



The illustration above shows a side elevation of the track structure with the toy figure in various positions of movement. The runway or track is made in two sections.

Safety Boat

No. 1,697,420, issued to Alfred Faussett. This invention provides a boat adapted to navigate falls or other dangerous waters and is so designed as to afford a thrilling spectacle for moving pictures, and yet, at the same time, to be safe and practical. In the boat are a number of rotatable drums controlled by brakes and carrying lengths of wire which are anchored on the shore in such a way as to safeguard the passage of the boat while the wires are concealed from the observer. The movement of the boat is controlled by the user through the brakes, drums and wires. Should the boat list to one side, the proper application of the braking mechanism on the other side will restore it to its usual balanced position. A spectacular effect such as turning over or tip-

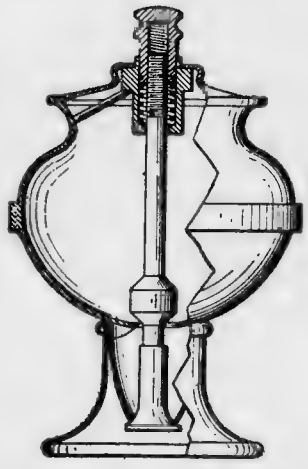
ping the boat can be produced by releasing the brakes on all but one of the drums and tightening the brake on the remaining drum. While primarily designed for the purposes described, the craft can be made applicable, by increasing its carrying capacity, to the transportation of supplies over water courses ordinarily unnavigable.

Notice to Readers:

These illustrated and described devices have recently been issued patent protection but are not as yet, to our knowledge, available on the market. We regret to advise that it is impossible to supply the correct addresses of inventors of the devices to any of our readers. The only records available, and they are at the Patent Office at Washington, D. C., give only the addresses of the inventors at the time of application for a patent. Many months have elapsed since that time, and those records are necessarily inaccurate. Therefore, kindly do not request such information, as it is practically impossible to obtain up-to-date addresses.

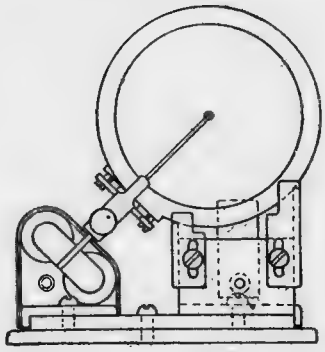
Sugar Bowl

No. 1,698,732, issued to Alexander M. Pasnik. The sugar container shown below can be adjusted for continuous discharge or for charge dispensing. The rate of discharge can also be regulated. The vessel has a container chamber and a small charge chamber



communicating by a throat with connecting valves on an operating rod and a screw adjustment, the setting of which determines whether the upper valve will close the throat or leave it open when the lower valve is unseated from the outlet of the charge chamber.

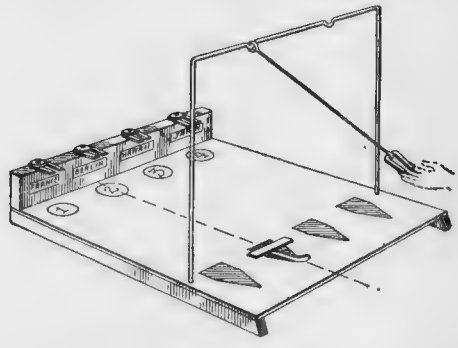
Radio-Phonograph Combination



No. 1,695,852, issued to Ward Leathers. The device shown here makes it possible to use the mica or other highly sensitive diaphragm of the phonograph for both radio and phonographic use. Another advantage gained is the fact that the same reproducing unit can be used for radio receiving purposes in connection with a phonograph horn. The sound reproducing instrument consists of a base for attaching to the frame of a phonograph and means for supporting the reproducer of a phonograph, an electro-magnetic device, including two pole pieces and a coil. An armature comprising a plate and a stem is adapted to be clamped in place of the usual stylus. Means are provided for adjusting the distance between the pole pieces and the plate. Whatever adjustment is required for correct radio reproduction need not be changed for phonograph reproduction.

Game Apparatus

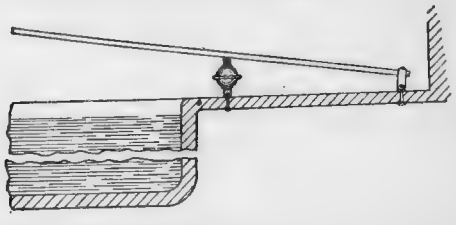
No. 1,695,624, issued to Walter W. Welpley. This invention provides a game of simple construction affording instructive and entertaining amusement. A permanent magnet is suspended so as to swing through an arc. Posi-



tioned in the path of the magnet are the game pieces to be attracted. The small airplanes used are picked up by the swinging magnet and transferred to a stationary magnet at the opposite end of the board. The power of the stationary magnet is greater than that of the swinging magnet. The game pieces are preferably made from soft iron and shaped to represent airplanes. If the swinging magnet is manipulated properly and the plane passes over one of the stationary magnets, it will by reason of the greater attractive power of the latter, be drawn downward, and a successful "flight" so concluded.

Springboard

No. 1,698,751, issued to Timothy C. Dobbins. This springboard is supported on a flexible spherical ball made of airtight material which contains air under pressure and which is therefore highly resilient. By means of this construction the plank which is ordinarily of springy wood can be made of rigid metal. Furthermore, a device of this type is practically noiseless and the upward throw can be limited by the action of the resilient ball or support. The pneumatic ball may be inflated to any de-



sired pressure by applying an air pump to the valve stem provided. By varying the pressure on the ball, its resiliency can be adjusted to suit any requirements. The pneumatic ball also acts as a snubber and limits the upward movement of the board.

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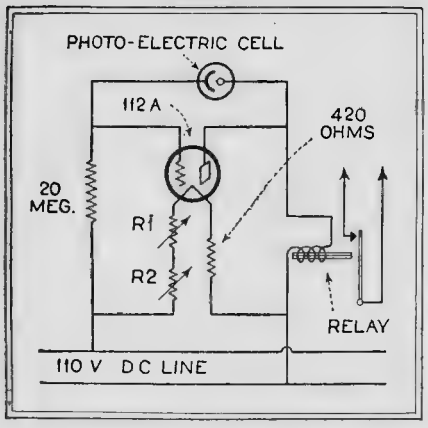
THE ORACLE

Opening Door with Light Beam

(2307) A. T. Manhion, Brooklyn, New York, writes:

Q. 1. A friend of mine recently told me that he had seen a means for opening a door with a flashlight. I presume that a photo-electric cell of some sort is employed but would appreciate the exact details. A 120 volt D.C. supply is available.

A. 1. You undoubtedly have reference to the opening of a garage door by means of a beam of light, which method was recently described by the Raytheon engineers, in connection with one of their photo-electric cells, which had an ionization potential of about 150 volts. The diagram here reproduced shows the hook-up of the apparatus. A 112 or 112-A type tube gave the best results. R_1 is a variable resistor of 200 ohms and R_2 is a 50 ohm variable resistor, while a third resistor of 420 ohms is placed in the other filament leg. When the particular cell used here is in darkness a current of about .25 milliampere flows



Above is a schematic circuit diagram showing how a photo-electric cell can be used for opening a door with a light beam.

in the plate circuit of the tube. When the flashlight is placed close to the cell, and shines upon it, a current of about 6.25 milliamperes flows. The relay used has a resistance of about 8,000 ohms and operates even when the flashlight is held at a distance of 10 ft. from the cell. The relay should act at about 2½ milliamperes and hold down at about 1 to 1½ milliamperes. The door may be swung open or slid back by means of a suitable motor drive. The supply to the motor is shut on and off by the relay. The arrangement shown has been designed to operate from a 120 volt D.C. line with resistors supplying the necessary "C" bias. "B" batteries could of course be used and many other variations could be worked out to suit the individual requirements.

Motion-Pictures of Jupiter

(2308) C. McClory, Dalton, Ohio, asks:

Q. 1. I recently read of moving-pictures taken of the planet Jupiter. Can you tell me how this was accomplished.

A. 1. The motion-pictures mentioned were made by taking an exposure about once every minute during the night. This procedure was repeated several nights when Jupiter was high in the sky. The 36 in. telescope at the Lick Observatory was used. The individual negatives were combined on a motion-picture film and when projected on a screen showed not only the planet itself but one of the moons revolving about it. One of the staff of this publication recently had the pleasure of viewing these moving-pictures taken with infra-red, ultra-violet and blue filters.

The "Oracle" is for the sole benefit of all scientific students. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

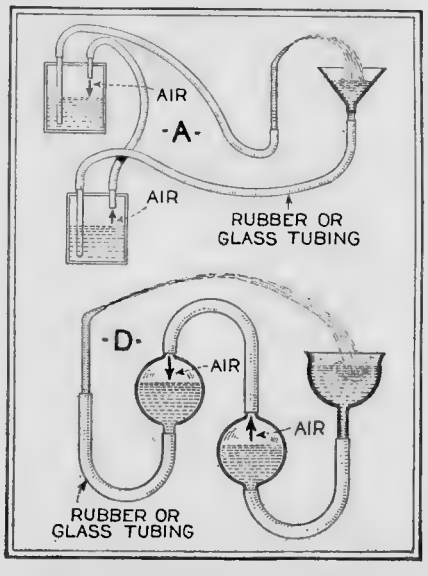
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 50 cents is made for each question. If the questions entail considerable research work or intricate calculations, a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

Laundry Soap

(2309) August De Gostine, Asbury Park, N. J., asks:

Q. 1. Will you please give me the necessary information for making ordinary laundry soap?

A. 1. A good, hard soap may be made from lard or tallow and caustic soda, sodium hydrate, without any special processes or manipulation required. The caustic soda is the crude article obtainable from drug stores at a moderate cost. A lye of average strength is made by dissolving the caustic soda in water in the proportion of about two pounds to each gallon. For the saponification of the lard a given quantity is melted at a low temperature and one-quarter of its weight of lye is then added in small portions with constant stirring. Another portion of lye equal to the first is added when thorough incorporation has taken place in the first instance. The mixture is kept at a gentle heat until saponification seems to be complete. If the soap does not separate from the liquid more lye should be added, the soap being insoluble in strong lye. When separation has occurred pour off the lye, add water, heat until dissolved and again separate by the use of a strong lye solution or a strong solution of common salt. The latter part of the process purifies the soap and can be omitted where only a crude article is desired. The soap is finally remelted on a water bath and kept at a gentle heat until as much water as possible is expelled. It then may be poured into molds and allowed to set.



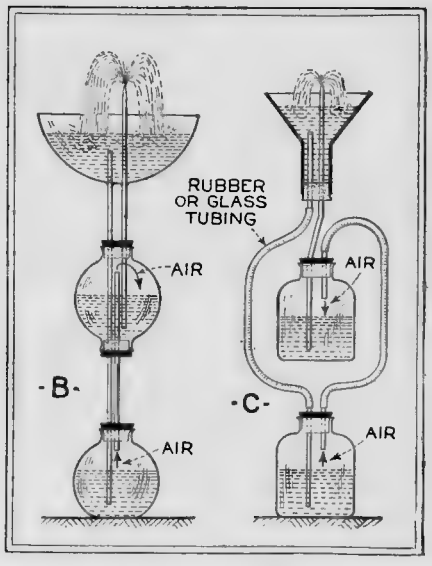
A simple form of fountain which operates by air pressure is shown above at A. D, illustrates a variation of Hero's fountain.

Continually Flowing Fountains

(2310) H. Poscacheck, Miami, Florida, writes:

Q. 1. I would like to construct a simple fountain which would flow automatically for some length of time. A drawing, and an explanation would be appreciated.

A. 1. On this page you will find an illustration which shows clearly the construction of a number of different types of fountains which will flow from two to four hours continuously, depending upon their size and care taken in the construction. They all operate on the same principle, inasmuch as these types of fountains are pneumatic in principle and throw a jet of water upward by means of the pressure of condensed air. A simple form of this apparatus is shown at A. Two bottles or tanks are employed with two tubes tightly sealed in them as shown. Rubber or glass tubing can be used for connecting the various parts. In order to start the fountain, water is poured into the funnel, runs down into the lower receptacle



C, in the above illustration, shows the construction of a fountain using a funnel and two bottles. B, is a fountain of similar design.

and compresses the air which is forced into the upper receptacle. The air pressure gradually increases until it reaches a point where the water in the upper receptacle is forced through the tube and issues from the spray nozzle. This nozzle should be bent as shown, so that the stream of water issuing therefrom falls into the funnel, continuing the flow for some time. B, shows a variation of the same type of fountain. In this case, the water falls back into the upper tank and then runs down to the bottom bowl, compressing the air and forcing it upward, as shown by the arrows. C, shows how this fountain can be constructed with a funnel and two bottles. D, shows a model of a fountain similar to that accredited to Hero. A glass delivery tube, three pieces of rubber tubing, two glass bulbs and a nozzle are all that are required. They should be assembled as shown with the parts placed in the relative positions indicated. When water is poured into the delivery tube, the air is compressed as shown by the arrows and will drive the water from the nozzle. The length of flow depends upon the constriction of the nozzle. In constructing the fountains, care should be taken to have all joints air and water-tight. If the air escapes, the system will simply become full of water and will not operate.

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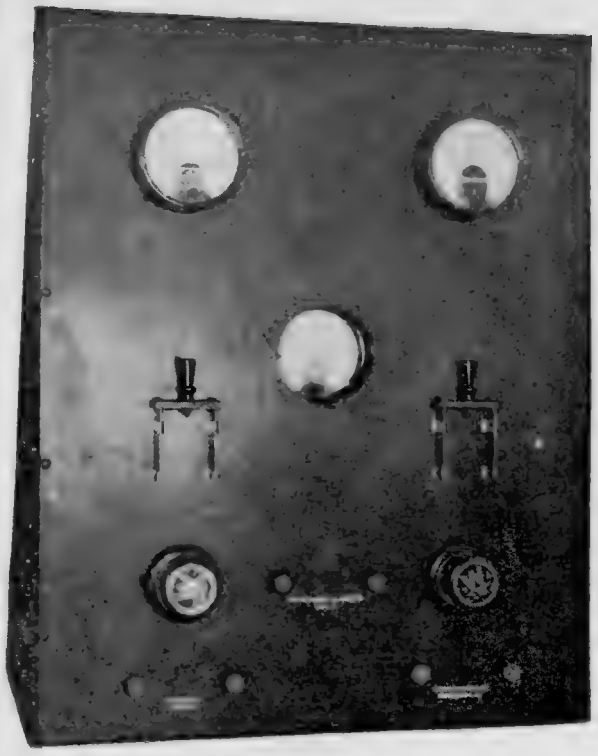
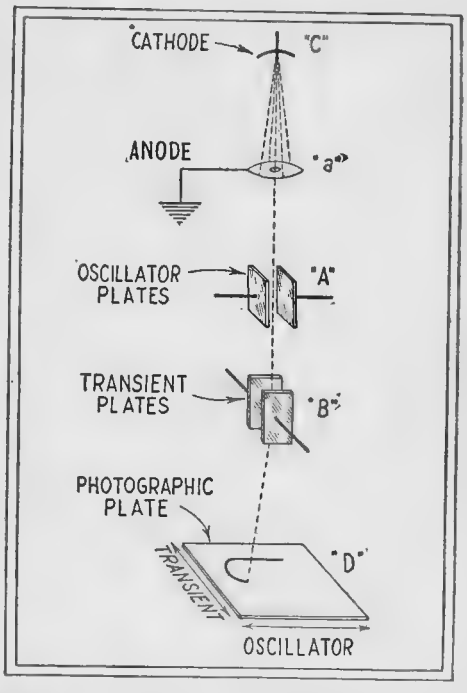


A front view of the high-frequency control panel for use with the oscillograph is shown above.

The right illustration shows the principle upon which the Norinder oscillograph works. A constant stream of electrons originates at the cathode C and passes through a pinhole in the anode a. The stream passes between pairs of plates and is deflected by the electrostatic field produced by the charged plates. D is an ordinary photographic plate.



A rear view of the apparatus, showing the coils and bank of switches is shown above.

Lightning Writes Own Record

By Charles E. Krause

(*Continued from page 29*)

located at the far end of the line, the voltage of the traveling wave was momentarily doubled and then reflected back on the line with decreasing amplitude but of the same polarity due to the open-end effect of the transmission line. The travel and reflection back and forth of the wave along the line will continue until the energy associated with it has been lost in the form of heat in the various resistances and leakage paths.

The scientific study of transients on transmission lines caused by lightning requires that an accurate determination of wave form be made in order that a better idea of the steepness of these surges may be obtained. This determination can therefore best be made with an oscillator used in connection with a cathode ray oscillograph.

Anthemius and Zeno

ALTHOUGH the Romans did not have the steam engine, at least one story proves that they knew of the moving power of steam.

A feud existed between Anthemius, an architect of Saint Sophia, and his next-door neighbor, Zeno. To annoy his neighbor, Anthemius placed several boilers containing water on the ground floor of his own house. Flexible tubes, one issuing from the top of each of these boilers, were conducted through a hole made in the wall between the two houses which communicated with the space under the floors of the rooms of Zeno's house.

When Anthemius wished to annoy his neighbor, he deliberately lighted fires under his boilers. The steam produced rushed under Zeno's floors in such quantity and with such force that the floors heaved with the usual symptoms of an earthquake.

(*See Chapman & Hall—"A History of Wonderful Inventions."*

—*Contributed by J. Abrahams.*

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Stage Scenes Shifted by Electro-Mechanics

By H. W. Secor

(*Continued from page* 15)

Television a Feature

TELEVISION played a considerable part in this play and it was simply and cleverly contrived. When one of the actors wished to switch on the television screen, on the rear wall of the room scene, he manipulated a switch just below the circular screen and presently one saw the illuminated face of an actor coming closer and closer, while at the same time the actor's voice was heard. The television voice, in such cases, was picked up on a microphone placed on the back of the rear wall, and the voice currents were then carried to a powerful vacuum tube amplifier, from which point they were led to loud speaker horns placed at either side of the proscenium opening.

In one of the elaborate television scenes, a pair of hands is seen to play a piano in a mysterious vertical position, and how this is accomplished is clearly shown in one of the illustrations. This trick scene could easily have been produced by means of a mirror or piece of glass placed at an angle, but instead, the actor who had carefully rehearsed the movements of the fingers, so as to correspond with the person who actually played on a real piano some distance away, lay on a table as one of the pictures shows, the dummy keyboard and the hands only being illuminated by a strip light.

Voice-Operated Typewriter

A VOICE-OPERATED typewriter will in time come into regular use and in this play, such a machine was demonstrated in actual use. An electrically operated typewriter of standard pattern was used in building up this scene, and this particular stunt was put over as follows: The actor spoke the whole message of 20 words into the microphone, shown in the picture, and when he replaced the microphone on the typewriter desk, the typewriter started printing the letter at a furious rate. The machine's keys were operated by means of a previously perforated paper roll and electro-magnets.

(*In the actual voice-operated typewriter of the future, it is considered by engineers that the machine will write the words as they are spoken, but this stage demonstration was cleverly worked out.*)

Mr. Ashley, who conceived and produced this really remarkable production, is entitled to a lot of credit, as it is probably the first time that practically all of the major scene changes were arranged to be made by a single operator, who simply had to throw in a single switch. By moving this switch to one set of contacts, the electric motor operated in one direction, and moved the scenery from right to left. When the switch was thrown into the second set of jaws, the motor was operated in the reverse direction and the scenery moved from left to right.

The transparent ceiling was anchored permanently in place and a large number of powerful colored lights, under the control of the stage electrician, helped to illuminate the scenes to various degrees by flashing the lights through the transparent ceiling. The ceiling was also arranged to be raised if so desired. The rear walls of the room were moved along with the main scene.

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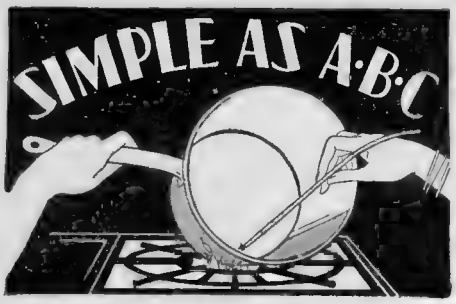

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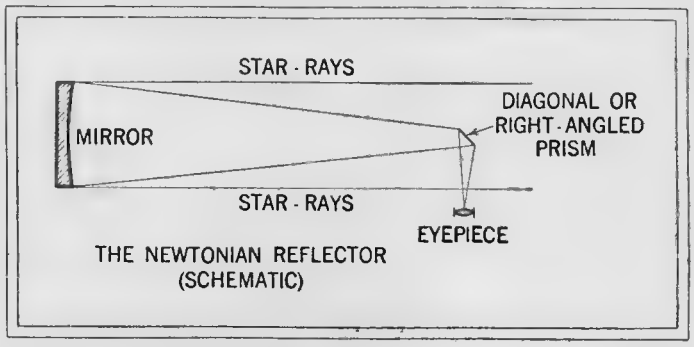
How to Build a Reflecting Telescope

By C. E. Barns

(*Continued from page 37*)

carborundum flour, fill with distilled or rain water and shake well. Allow to settle for one minute, then pour off the cloudy water into a second jar. Allow to settle for ten minutes, and pour off into a third jar.



A schematic representation of the Newtonian reflector is shown at the left. The star rays are reflected from the speculum and strike a right-angled prism from which they emerge to strike the eyepiece.

After half an hour, pour into a fourth. It will look like clear water, but the abrasive is there in suspension all the same. Spooning out a little of each of these grades, proceed as before. You will have then a perfect polishing surface.

Polishing Reflector

BEFORE proceeding with the polishing process, *clean everything*, change aprons, and if possible, remove post, tool and all to another room. If not, cover over all abrasives and avoid draughts; for one microscopic grain of grit on your speculum now means going back and grinding out the scratches.

In a clean fruit-jar place about a quarter-pound of rouge, fill with water, shake, letting it settle for a few minutes. Pour off into another jar, and after it has settled clear, pour off all the water and spoon out the "washed" rouge as needed. In an agate-ware dish melt a half-pound of the pitch. Add a little turpentine if too hard. Strain, as suggested before, and after wrapping around the circumference of the tool a strip of wax paper to hold in the melted pitch, pour in to the depth of a quarter-inch, evenly as possible. Remove wax paper, and after wetting the face of the speculum with soapy water, seat it carefully on the soft pitch, moving it round and round till you have a perfect fit. When hard, lay a straight-edge across the convex pitch-pad and cut grooves as indicated in the illustration, leaving only the squares. Cover these squares with the washed rouge and proceed as with fine grinding. The speculum will take on a brilliant polish, from periphery to center.

If your skill and patience have produced for you a perfect spherical figure, you have done well. But it may be that you will seek further perfection by a process of parabolizing—that is, a deepening of the center of the speculum so that all rays will converge as near as possible to the focal point. In large specula the parabolizing and an intricate testing process is imperative and most exacting; but in an eight-inch, or smaller, very little deepening is necessary, and one eminent authority does not advise it at all. It is accomplished simply by cutting down the size of the outer squares of the pitch tool so that the central ones will wear down the mirror over its deepest areas to an amount only perceptible by the Foucault test.

Testing Mirror

THE spherical test consists of setting up the mirror at twice the true focal distance—the center of curvature—and employing an artificial star produced by piercing a tin cylinder with a needle and setting behind the orifice a small oil lamp or frosted-globe electric light. At the left, quite close, is set upright a common safety-razor blade. By shiftnig both lamp and blade till the proper position is found, a point will be discovered where the "star" will be seen to illumine the entire surface of the speculum and reflect it back in the form of a cone. By bringing the eye close to the blade and advancing it to the point where the rays cross, the disc will be seen to darken over its entire surface. If the shadow starts from the right, the blade is inside the focal point; if from the left, outside. At the exact point the illumination vanishes evenly. Obviously, then, if there are zones of depression or raised portions on the surface of the mirror, this test will reveal them. Under this test a true paraboloid figure will show a symmetrically raised middle zone between a depressed periphery and central area. Examined with a low-power eyepiece, a "star" at the radius of curvature will be seen as a brilliant, ragged-edge enlargement of the needle-hole.

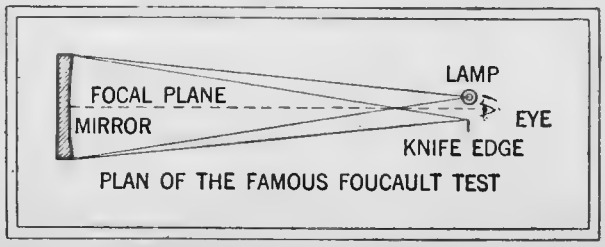
Silvering Mirror

THERE are many formulae for silvering, but the following is simple and costs but a few cents per trial, so failure is not a great matter:

Label four clean quart bottles, A, B, C, and D. Solution A—Nitrate of silver, 175 gr., distilled water, 10 oz. Solution B—Ammonium Nitrate, 262 gr., distilled water, 10 oz. Solution C—Cube sugar, half-oz., distilled water, 5 oz. Dissolve, and add Tartaric Acid, 50 gr. Boil in glazed dish 10 minutes. Add pure grain alcohol (now usually sold with formaldehyde added), 1 oz. Water to make 10 oz. Solution D—Caustic Potash, 1 oz. Water, 10 oz. All chemicals must be absolutely C. P.

Make a "dish" of the speculum by running around it a tight strip of wax paper 3 inches wide. Wear rubber gloves. Go over

The plan of the Foucault test is shown at the right. The spherical test for the mirror is made in this manner. Under this test a true parabolic figure will show a symmetrical ray's middle zone between a depressed periphery and central area.



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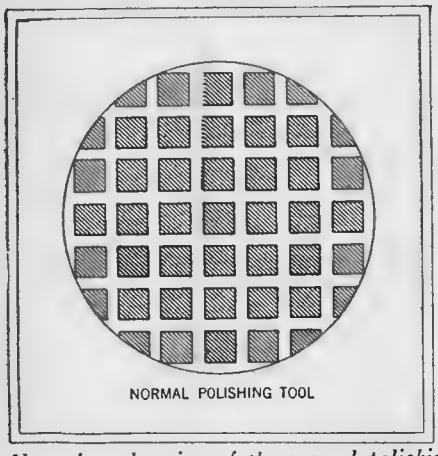
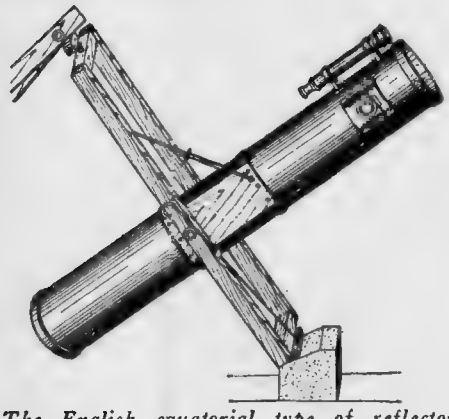


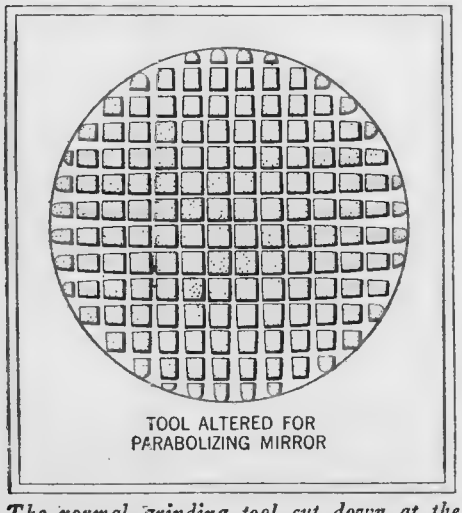
Above is a drawing of the normal polishing tool. This is covered with pitch.

every part of the mirror with a wad of gauze dipped in nitric acid. Wash again and again. Cover with distilled water and let stand in room temperature about 65 degrees F. Into a clean measuring glass pour one ounce of Solution A, adding one ounce Solution B. In another glass pour one ounce Solution C, adding one ounce Solution D. Throw off water from speculum, but do not let it become dry. Mix contents of both measuring glasses. Solution will turn amber, then darken. Flow over speculum and rock vigorously. The silver will be seen to deposit quickly, then apparently become exhausted.

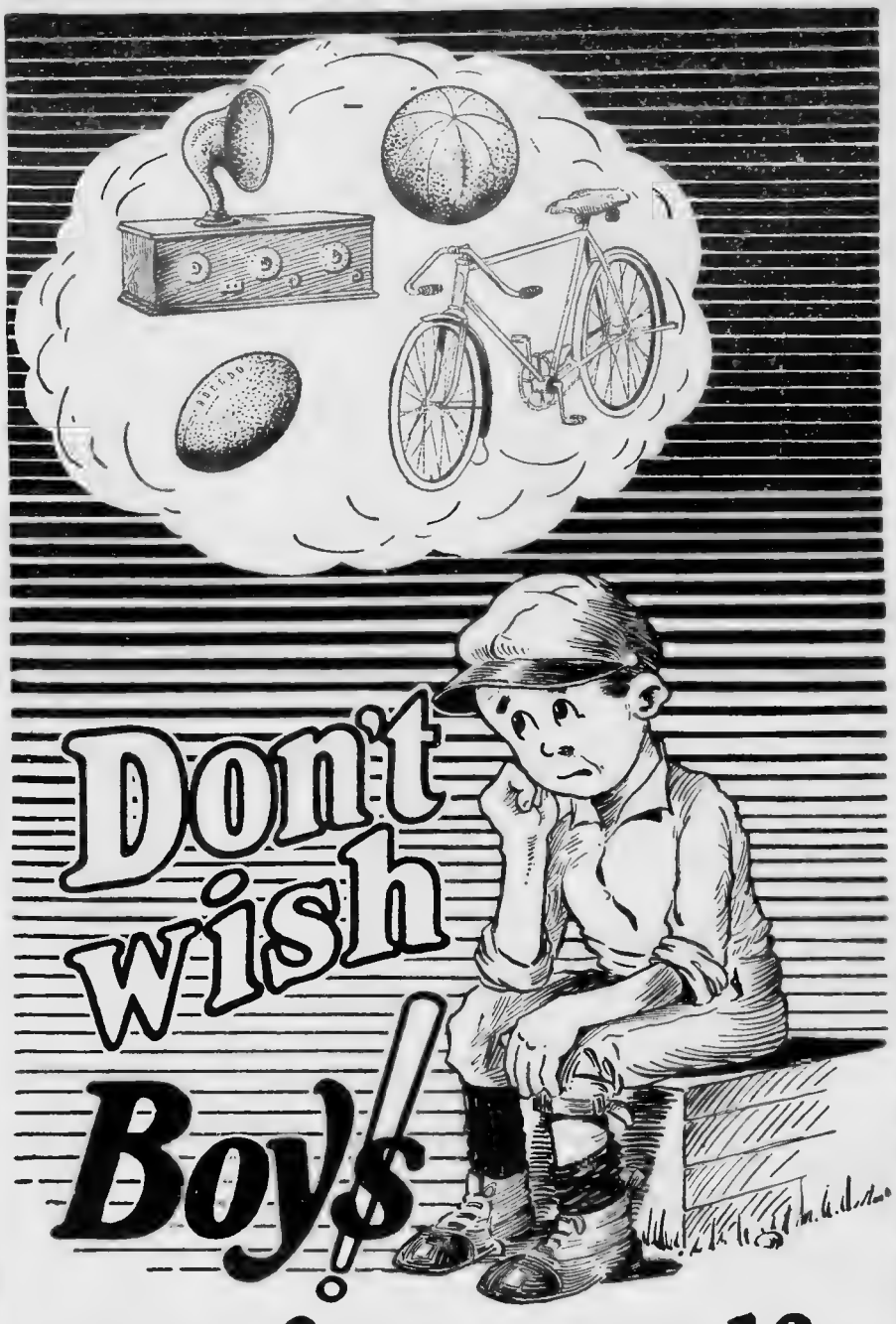


The English equatorial type of reflector mounting is illustrated above.

Throw off and cover with water. Mix solutions again and proceed as before three times, when a fairly thick film of silver will cover every part of the glass. Rinse several times with distilled water, then set on edge in the sun to dry. The following day polish with chamois and bone-dry rouge.



The normal grinding tool cut down at the periphery is used for parabolizing the mirror.



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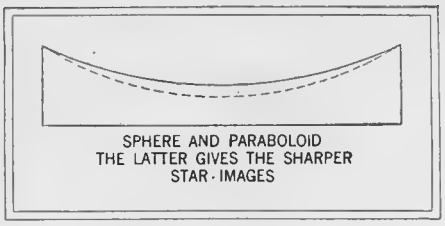

SPHERE AND PARABOLOID
THE LATTER GIVES THE SHARPER STAR-IMAGES

A spherical speculum with the dotted lines indicating a deepening of the central areas in the form of a parabola, in order to bring all of the reflected rays to one focal point.

two; an English type of "parallactic ladder," a plain equatorial, or one of the stationary eyepiece variety, as illustrated, or one still more costly and elaborate, with driving clock, costing some hundreds. All illustrations shown are by amateurs, showing their deep love and aptitude for this delightful work.

In the matter of accessories, they need be likewise simple and inexpensive. An oval "flat" may be cut from a discarded windshield and silvered, serving as a diagonal if one cannot afford a right angle prism; and microscope eyepieces, costing a couple of dollars, make very efficient oculars for a reflector. A sliding-tube mounting for the same is easily made. A field-glass, with erecting train removed, serves very well for a finder.

Altogether with care and patience the telescope-builder should have an instrument of which he may well be proud, and enable him to bring the celestial splendors to his vision with clearness and brilliancy.

A Remarkable New Cell

By C. A. Oldroyd

(*Continued from page* 46)

discharge, we can take ninety-three per cent. of the energy spent in charging, or 93 ampere hours, out of the battery; we only lose seven ampere hours. This is the very low interest we have to pay our battery to take care of our electric energy for us, until needed. The loss of seven per cent. is shown in the black section "X."

This wonderful efficiency alone would suffice to make the Almeida battery welcome wherever storage cells are used; but the new design scores heavily in other directions as well, namely in weight and volume for a given capacity.

Weight Compared to Lead Cell

TO use a concrete example: an Almeida cell of one hundred ampere hours capacity weighs only as much as a lead cell of ten ampere hours capacity. For the same capacity, the Almeida type turns the scale to one-tenth the weight of a corresponding lead cell. Graphically, the huge gain is illustrated in Fig. 5.

To these advantages, we must add another: the discharge voltage of the new battery is higher than that of a lead cell. Research is still going on to improve the new battery still further; life tests are being made, and manufacturing problems studied.

Many of the details of construction are kept secret, this merely as a warning to the keen experimenter who would like to try his hand at making up a sample battery.

As soon as the final type is ready for commercial production, the correspondent of SCIENCE AND INVENTION will report in greater detail. Until then: we must "wait and see," as a great statesman put it!

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Radio Tubes Control Elevator

By W. O. Lum

(*Continued from page* 56)

rent occurs when the circuit goes in or out of oscillation. The plate current will be low when the circuit is oscillating and high when oscillation ceases.

Relay

IF now an electro-magnetic relay is connected in series with the plate circuit and the relay coil by-passed with a capacitor, the difference in plate current through the relay coil will be further increased between the oscillating and non-oscillating states because the highly inductive relay coil will not pass radio frequencies but the capacitor in multiple with this coil will, and in a non-oscillating condition the capacitor will pass no current and the relay coil will freely pass the direct current. The operation then will be that, with the vane between the grid and plate coils, the relay will be operated by the direct current and, with the vane absent and the circuit free to oscillate, the relay will be open. The pliotron unit shown in photographs has approximately 1″ air space between the grid and plate coils, and 1/16″ radial movement of the edge of the vane between coils is sufficient to pick up and drop out the relay. This pick-up and drop-out distance may be reduced if requirements demand.

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The photograph shows a group of pliotron units mounted on the cross-head of an elevator car as used in a pre-registering signal control elevator system.

The up and down leveling relays are so connected in the circuit of the directional contactors on the elevator panel that one relay must be energized and the other de-energized in order to get direction. If both relays are either energized or de-energized at the time there will be no response of the control.

The frequency of the oscillating circuits is approximately 200 kilocycles and the plate voltage is the power line voltage.

Mode of Operation

THE relays govern control circuits which stop the car at the correct position. In operation, the operator throws the car switch "off" as he approaches the floor at which the car is to be stopped. On nearing the floor, the metal vane passes between the grid and plate coils and the relay is actuated, bringing the car to a stop at the floor level without the attention of the operator. After stopping, the car is started in the usual manner.

Signalling Equipment

WHEN each passenger enters the car he calls out the number of the floor at which he wishes to alight and the operator presses a push button opposite this number on a control panel. As he approaches the first floor at which the car is to stop, a light flashes and a bell rings, and he then throws the switch to the "off" position. The car continues at full speed until it is slowed up automatically and brought level.

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Every day there's a new edition of
The Passing Show!

Constructing a Phonograph Pick-Up

By G. F. Lampkin

(*Continued from page* 59)

simultaneously, the soldering iron removed, and the two pressed together till fast.

Tone Arm

THE dimensions and parts for the tone arm are depicted in the drawings. The counterbalance is used to prevent undue wear on the record, with the given dimensions, the force on the record will be about 6 ounces. The horizontal arm at the pivot is tapped and drilled 6-32. Two ¼" 6-32 screws are put in from each side of the pivot bracket. If necessary, one screw should be filed down till it just makes a snug fit on the bracket, when tightened down. It is necessary to fill the base for the tone arm with lead, in order that it will be sufficiently stable. Some 2½ pounds of lead in sheet or pipe can be melted in an old pan on the kitchen stove. The brass sides of the base are cut and bent to shape so as to leave as small cracks at the edges as possible. It will help in bending to get a ⅝" square stick and clamp it in the vise, upright, and do the bending over the protruding end. The brass shell is placed on a board and wooden cleats fitted and nailed about the base to hold it together and in position. Then the melted lead is poured through the hole in the top till the shell is full. After cooling, the ⅜" hole for the pivot is drilled, and the entire unit assembled.

Scratch Filter

AS electrical accessories, pick-up units usually have a scratch filter, a volume control, and a plug for inserting in the detector socket of the receiver. The first mentioned item is not absolutely necessary in this case. Unless the volume from the pick-up is turned way up the record noise is so submerged as to be unnoticeable. Emphasis of the low notes can be obtained by putting condensers, up to 0.25 mfd., across the unit. Capacities of 0.05 or 0.1 mfd. gave likeable reproduction in the particular combination of pick-up, amplifier, and loudspeaker, which was used. And of course the bypass condenser submerges the record noise just so much more.

Volume Control

A 250,000- or 500,000-ohm variable resistor does suitably as a volume control, when connected across the pick-up unit. Either a potentiometer or shorting resistance type of control is satisfactory. The plug for detector-socket input to a receiver may be made from the base of an old tube. Simply break out the glass, unsolder the wires to the prongs, and then resolder in the filament and plate prongs the output leads from the pick-up device.

The damping on the Baldwin unit aids materially in securing a high quality output, in addition to silencing the mica diaphragm as a sound source in itself. The voltage output from the home-made unit averages some 0.25 volts when activated by a soft needle.

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THE CONSTRUCTOR'S OWN PAGES ON THE SHORT WAVES

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New Study of Plant Roots

By James R. Lowell

(*Continued from page* 30)

carrot that we gather from our garden has a root penetration of over eight feet.

The "why" of existing cultural practices in crop production was determined by the Nebraska botanist. The eradication of weeds when young has always been stressed, but the sole reason assigned for this practice was to prevent the robbing of water and nutrient from the cultivated plant by the weed. This reason now has been supplemented by another, the fact that the deeper cultivation necessary to remove weeds of more established growth also tears up the roots of the crop.

Cabbage is generally known to be "hard on the land." The reason for this may be found in the root system of the plant which is extensive and highly branched, thoroughly occupying the surface foot of soil and thus heavily depleting the topsoil of its moisture and nutrients. The superficial position in the soil of many of the roots of the cabbage plant shows that this crop, as well as corn, should be cultivated sparingly. The profusion of rootlets in the surface soil makes for practically no loss of water by evaporation, therefore cultivation for the purpose of conserving moisture by forming a surface mulch, as commonly practised, is undesirable after the plant has well established itself.

The adaptation of certain plants to cold or dry sections of the country, spacing of seeds or seedlings, effect of fertilizers on plant growth, and the susceptibility of plants to diseases, all are closely concerned with root development and character. In view of the extreme in importance of the subterranean part of the plant, Doctor Weaver's work has met with high acclaim in botanical circles the world over.

The method by which he might study roots in their entity was the first problem that confronted the pioneer. The method usually employed had been to wash away the soil from the root system by playing a stream of water on the plant. This method had several obvious faults as the force of the projected water would break many of the fine roots and the natural position of the roots in the soil could not be maintained. In some cases forms had been used by the botanists to hold the roots in position against the force of the water.

But Doctor Weaver perfected a system of trenches whereby he could follow the root course without removing the plant or breaking any of the fine rootlets and root-hairs. The trench system entails considerable hard work but it is efficient.

The trenches were usually dug to a depth greater than a man's height, and were necessarily roomy enough to allow free play of the arms of the workers. A hand-pick and an ice-pick were used to excavate around the roots, and several days were often required to expose the root system of one small plant.

A few years after the work was inaugurated, the Carnegie Institution at Washington, D. C., became interested and took Doctor Weaver under its wing. The Institution made it possible by financial support for him to continue his work and is still backing him. A number of students aided in the investigations helping to excavate the trenches and keep records of the findings. Coauthors who have helped both in the gathering of data and the actual research are Dr. Frank C. Jean, Dr. John W. Crist and Prof. William Bruner.

The investigations were confined for the most part to three states, Nebraska, Okla-

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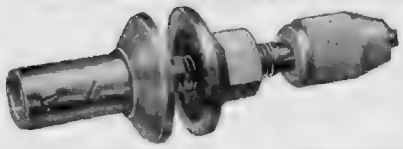

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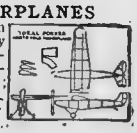

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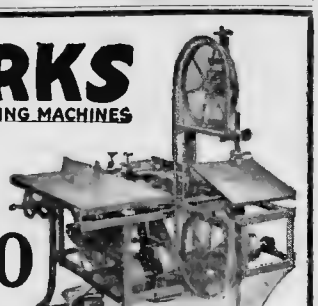

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homa and Colorado. Findings were compared where possible with data from other parts of America. Foreign investigations by Osvald, Schulze, Rotmistrove and Vorobev of Europe, and Howard in India were studied to some extent.

Twelve years ago Doctor Weaver's first book, "Root Development of Field Crops," was published, and during the past year another volume, "Root Development of Vegetable Crops," came off the press. These volumes are the only treatises on root study listed in the extensive series on agricultural and botanical sciences published by one of the largest publishers of New York City and London.

Botanical journals in America and England especially are praising the pioneer efforts of the Nebraska botanist, and reviewers have recommended his findings for study in the universities and colleges of the country. Botanists in Russia, Germany, China and India are also passing favorable criticism on his work.

Doctor Weaver has spent some time specializing on the study of root habits of native plants which are of great value in view of their indication in a general way of how cultivated crops are likely to behave when grown in the same region. He says:

"It is of more than passing interest that the cereal crops, viz., corn, spring and winter wheat, oats, barley, sorghum and millet, all of which are grasses, have their center of greatest production in that portion of the United States originally covered by grassland. In fact, some are grown almost entirely in this region, and other crops such as alfalfa and flax, which are similar in growth habit to wild legumes, wild flaxes, etc., growing among the grasses, also have their greatest acreage in the grassland. Likewise the greatest areas of fruit production are in those portions of the United States formerly occupied by native species of similar habits, i.e., forest trees and shrubs.

"Where water content of soil is the chief limiting factor to growth, knowledge of root extent and the length of the growing period are important factors. The luxuriance and diversity of the vegetation are also good indicators of crop possibilities. The deep-rooting habit, long-growing season, variety, and luxuriance of tall-grass prairies species all indicate favorable moisture conditions in soil and subsoil throughout the entire summer. It is here that many cultivated crops make their largest yields. Likewise the shallow-rooted plants of the short-grass plains, together with their shorter period of growth, indicate clearly less favorable or even hazardous conditions for crop production. The development of both native vegetation and crops is intermediate in the broad intervening area of mixed prairie."

The importance of grass in relation to soil structure and productivity has been accentuated by Doctor Weaver's explorations among the roots. Grass is recognized as natures' remedy for worn-out soils, restoring productivity and good tilth. The interweaving of the root systems of grass forms sod and prevents the harmful puddling action of rain, and as the roots develop, the soil particles are wedged apart in some places and crowded together in others, improving the texture of a worn-out soil. Small soil grains are built into larger ones. The death of old roots forming pores in the soil, and the humus from the decaying roots, all tends to restore the mellow texture characteristic of virgin soil, besides adding greatly to soil fertility.

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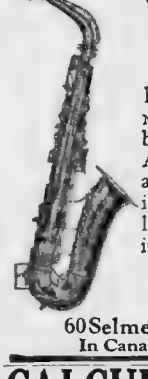

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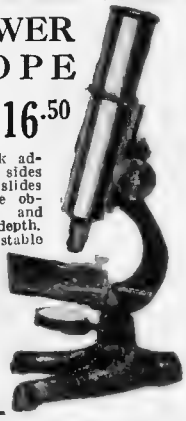

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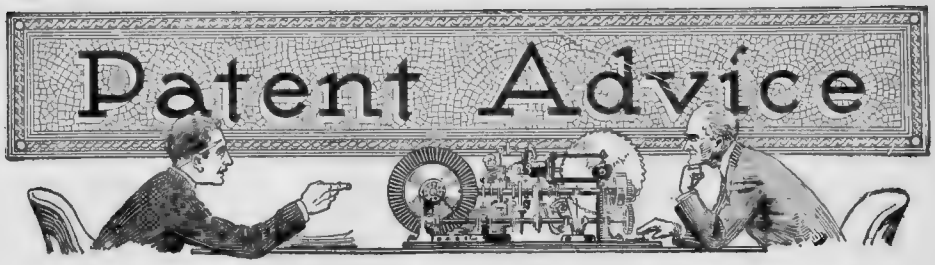

CONDUCTED BY JOSEPH H. KRAUS

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain patent phases. Regular inquiries addressed to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are published here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge all details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail, a nominal charge of $1.00 is made for each question. Sketches, and descriptions must be clear and explicit. Only one side of sheet should be written on.

NOTE:—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

Colored Crutches

(1166) Russell Baker, Monroe Corner, N. Y., is desirous of protecting a crutch with spring shock absorbing tip and painted wood portions.

A. The painting of a crutch any color is not a claim for a patent. The only possible claim for a patent which you have, is the design of the particular type of spring tip which you intend to add to this crutch. The advantages of such a spring are not very apparent to us because rubber presents shock-absorbing qualities and the individual feels more assured of a substantial footing if no spring is in the end of the crutch than if one is there located.

While it is true that the pistons of a trumpet move very easily without wobbling from side to side, they are made with a high degree of precision, and it would not be logical to machine a crutch with the same degree of accuracy. Also, instrument valves do not come in contact with dirt and dust as would the end of a crutch.

We do not advise a patent on the spring mechanism. We are confident that no patent would be granted on the painting of crutches.

Protection

(1167) Joe Wise, Nods, Wyoming, asks several questions, the natures of which are made clear in the answers.

A. It is not necessary to send an actual working model or sample to the patent office unless they are unable to understand your drawings, and specifications. In the latter case, a crude sample made of wood may serve the purpose. There is only one exception to the general rule and that is in the case of a perpetual motion machine or a mechanism claiming to produce perpetual motion, in which event the actual working model must be submitted. In your application it is not essential that you mention what the packing nut is to be used for but it is occasionally advisable to do so.

The mere fact that you do not encompass every use on which such a nut can be employed will not prevent you from establishing a claim to its use on such machinery. If anyone finds another use for your device it does not in any way disturb the value of your claims. The principle or the idea is the thing that is patented.

The "strength" of your patent depends entirely on your claims and unless you are an attorney and able to draw up strong claims your patent will be of little value. The government does not guarantee that your idea will be fully protected from every angle. You must protect it yourself.

Lighting System

(1168) Harry Gilbert Smith, Jr., asks if a patent can be obtained on a lighting system for school blackboards. If not, he wants to know why such systems are not in general use.

A. One cannot obtain a patent for the use of an article—Therefore, it is quite impossible for anyone to secure a patent on a lighting system for blackboards, made as you have indicated. In many places blackboards are illuminated in the manner you have illustrated. This is particularly so in museums where lectures are given. Unless the light bracket is far enough away from the blackboard it produces several "high light" spots and the blackboard then cannot be clearly seen from different angles.

If the lights are about 1½ ft. from the blackboards and illuminate the blackboard in much the same manner as signs are illuminated, the system would work very well. Why schools do not use it is something difficult to say, but it is probably that the cost is the greatest item. It is far better to erect a half dozen more new schools than it would be to install thousands of dollars worth of illuminating apparatus and spend thousands of dollars keeping such illuminating apparatus in repair and service.

Bottle Caps

(1169) George Bedard asks if he should patent an idea of a bottle cap that requires no tool for removal.

A. There are many bottle caps on the market that requires no tools for removal. One of the simplest is a cap with a tongue extending downward and when the tongue is grasped the entire cap can be torn off. The system is both practical and commercially satisfactory because it can be placed into the ordinary bottle cap machines and no extra equipment is needed. The only reason that these bottle caps are not used on soft drink bottles is that the manufacturers do not care to put them on. They are no more expensive than the bottle cap obtained today and they answer the purpose just as well.

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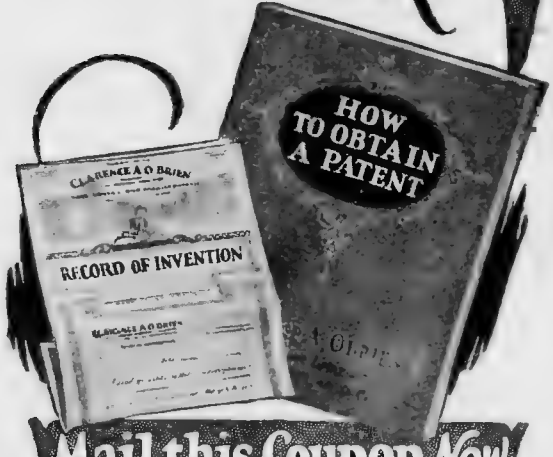

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Could You Qualify as a Cop?

By Uthai Vincent Wilcox

(*Continued from page* 18)

and general appearance was broadcast. Photographs followed. But although the reward came to thousands of dollars, Hickman traveled nearly the length of the western coast of California through innumerable cities, was stopped and questioned, but was not caught until someone was encountered who had a good memory.

With this in mind: The Examiner passes out photographs of 10 persons whose faces are to be remembered, Fig. 2, placing the print face down on the desk in front of each patrolman. Each man is given exactly 1½ minutes to study the faces. Each face is well marked and it is noted that all are of different races, builds and types. No notes are allowed.

When the minute and a half is up, the first page is taken away and other tests are given. In fact, two hours must pass by and then the doughty patrolmen are given other sheets of 48 faces, Fig. 5, and 10 minutes are given to identify among the 48 the 10 individuals shown two hours previously. In order to make the identification still more exact, the numbers are later written in on the blank spaces attached to each one of the ten.

Such are but a few of the tests that the modern patrolman must pass where the commissioners cooperate with the Bureau of Public Personnel Administration at Washington. And many cities are lining up. In fact, Berkeley, California, and other cities have been using such tests for some time and have reported a reduction in crime, better officers and kindlier feeling between citizens and patrolmen. The intelligent policeman is the ideal, and the more intelligent the better. If tests will find the brightest ones, the criminals will give the city having them a wide berth. They don't like brainy cops.

Traffic Problem

THERE are other tests for observation and for memory which include the vexing problem of automobile traffic and accident. For example, a photograph of a street car with an automobile standing beside it while a passenger is alighting (Fig. 3) is supplied for the specified 1½ minutes. The questions relating to it are:

1. What traffic law is being violated?
2. At what place (street intersection) is the violation taking place?
3. What is the number of the street car?
4. What license tag is the automobile carrying?
5. What officer of the law is observing the situation?
6. What is the make of the automobile?
7. Is the day clear or cloudy?
8. What is the type of street car?
9. To whom does the automobile belong?
10. What type of body has the automobile?

Another view showing the fire department's equipment trying to make a connection with an automobile parked in front of the hydrant (Fig. 1). Using the same rules, five questions are asked:

1. What two traffic regulations are being violated?
2. What is the license number of the automobile?
3. What are the police and fire officers doing about the situation?
4. What is the place (street intersection)?
5. What type of body has the machine?

These tests do not stop with pictures. There are plenty of these. There are also lists upon lists of questions. Tricky questions, searching questions, questions that cleverly probe the mind of the patrolmen to find out just how the wheels go round and if he has the ability to act quickly, properly and lawfully when the emergency calls for action.

Cops Make Mistakes

THEY are human—are the cops. They make mistakes. They are in danger of making serious mistakes and frequently these tests will indicate it, such being the science of psychology as now applied.

Take the questions having a "multiple choice," meaning a number of answers are suggested and the patrolman must choose the right one. These are revealing and show graded intelligence. In fact, the memory and observation and all others can do their important part but the sheet of paper filled with such questions is hard. Here are a few:

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The one of the following qualifications most important in a policeman is:

—Ability to understand and get along well with people.
—Ability to write a good report.
—Ability to shoot accurately.
—Ability to overpower a strong man who resists arrest.

The perspiring copper must take his pencil in hand and check the right answer, and promptly. He can't chew the eraser doing it, either. Here's another:

(9) The one of the following types of criminals most likely to work in gangs is:

—Forgers.
—Street walkers.
—Vagrants.
—Pickpockets.

Or this one:

(16) If I were a Patrolman and on my rounds at night found the rear door of a department store unlocked, I should:

—Make sure that nobody is in the store, fasten the door and notify police headquarters and the owner and manager of the store.

(*Continued on page* 80)

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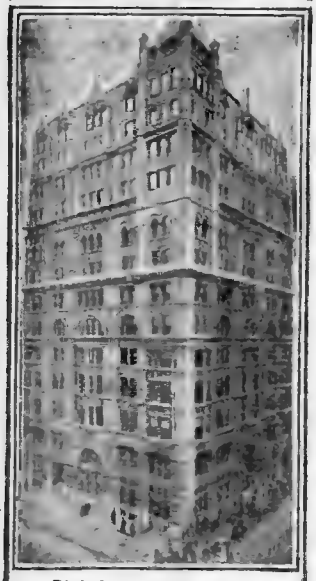

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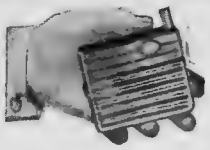

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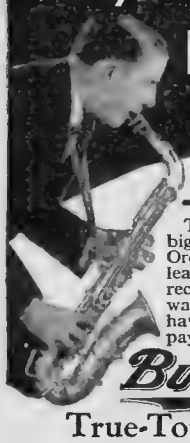

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Could You Qualify as a Cop?

(*Continued from page* 78)

—Enter the store, visit all departments to make sure that nothing is missing, and then fasten the door.

—Leave things as they are, as the owner probably left the door unlocked for good reasons.

—Leave the door unlocked but look around carefully on each round to see that no unauthorized person is in the building.

True or False

THEN there are the "True and False" tests. These, too, are tricky, even though the tired officer of the law with a bulging head and a red face and pounding temples has no more to do than putting a neat little circle around the capital "T" or the capital "F," standing for "True" and "False."

Here are a few examples:

T F—In case of a collision between two automobiles, one or both drivers should practically always be arrested.

T F—It is proper for a patrolman to recommend a good lawyer to a man whom he has arrested and who asks his advice.

T F—In firing at a man running away, it is better to stop and take aim than to fire while running.

T F—Taxpayers are entitled to more police protection than persons who pay no taxes.

T F—A United States soldier may be arrested by a city police officer.

T F—A search warrant may be served by a private citizen.

In New York the first police institute in the United States has just been inaugurated at Fordham University, its courses a gift to the city. Seventy-five grizzled police lieutenants, a bit puzzled, and 100 policewomen are going to school in the classroom in the 28th floor of the Woolworth Building. Chief Magistrate William McAdoo opened the school. He said:

"The old policeman of the Sullivan type is being replaced by the newer policeman with the higher mentality of a Tunney," said Magistrate McAdoo, who, however, had a word of praise for the old timers.

"They were fine cops of the good old days, God bless 'em," he said. "They were ample of back, rolling of front, strong of arm, hard of head, soft of heart, broad of feet, like a Percheron horse.

"But today there are new ways and new police. The New York police are walking advertisements of clean living and clean thinking."

Lieutenants assigned to welfare work and all policewomen are required to attend the school two hours one night a week. Lectures will be given by Fordham instructors and others.

Answers to Questions on Page 18

1. 105th Street and Boston Road.
2. Raining.
3. New York.
4. Left-hand side—driver's side.
5. Five minutes after three o'clock.
6. Front axle, windshield, fenders, top mudguard.
7. 1070.
8. Home Radio Co.
9. Skidding and inability to make turn or to stop.
10. Boston Road to West Farms.
11. No. 2.
12. February 25th.
13. Position of body and fact that auto was struck on driver's side and no attempt at giving any kind of first aid.
14. S. Brown, Dentist, who was looking from window.
15. Looking for identification letters in pocket.

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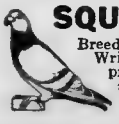

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The Air We Breathe

By Dr. William Lemkin, Ph.D.

(*Continued from page 49*)

which is a rather peculiar form of oxygen. Ordinarily oxygen exists as O_2, meaning two atoms of the element joined together to make a molecule of oxygen. Ozone has been found to have the composition O_3, and is known to exhibit powerful oxidizing properties because of this structure. It is produced from oxygen by electrical discharge. The peculiar pungent odor which is evident after a thunderstorm or in the vicinity of an electrical machine is due to this strange substance. In addition, ozone is formed in many other ways, as by the slow oxidation of phosphorus in moist air, and by the action of concentrated sulphuric acid on potassium permanganate.

To test for ozone we use special "ozone paper" made in the following way: Mix about five grams of starch with 20 c.c. of cold distilled water. Pour this mixture into about 100 c. c. of boiling water containing in solution about a gram of potassium iodide. Heat the mixture for a moment and then soak several strips of white filter paper in the solution. Allow these strips to dry thoroughly in pure air. When exposed to ozone this paper will turn blue, owing to the liberation of free iodine from the potassium salt.

If you have access to an electric motor or some other electrical machine, in which more or less sparking occurs, you may try out this paper by moistening it and testing the air in the vicinity of the electrical device. You may also produce some ozone by the slow oxidation of phosphorus and then employing the same test. Cut some phosphorus in thin slices, taking great care to do this cutting under water. Handle the phosphorus with a scissors, pincers or hairpin. Do not touch it. Place the slices in a jar with a little warm water in the bottom, but not enough to cover the phosphorus. Then hang some strips of moistened ozone paper in the jar and cover it. After a short time the presence of ozone will be indicated by the blue coloration on the test paper.

Other Rare Constituents

HYDROGEN sulphide is a gas which, although not usually present in pure air, may be found in the air of cities, generated from the decomposition of organic matter such as sewage. Frequently it may be detected by its characteristic rotten egg odor. To perform a chemical test for this disagreeable gas moisten some filter paper with a solution of lead acetate and expose to the air for about an hour. If there is hydrogen sulphide in the atmosphere the paper will turn black, owing to the formation of lead sulphide.

Indoor air is sometimes found to contain appreciable quantities of carbon monoxide, arising from improper ventilation or leaky furnace flues. Because of its highly poisonous nature, as well as its lack of warning odor, it is of the greatest importance to exclude it from the air of inhabited rooms. There is no simple qualitative test for the gas, but fortunately it is generally found mixed with other gases that have a characteristic smell. The penetrating odor of illuminating gas, coming from the sulphur compounds it contains, serves as a warning. In the case of escaping furnace gases, the accompanying odor of sulphur dioxide will serve to acquaint one with the lurking danger before it is too late. The air of cities may contain minute traces of carbon monoxide as a result of the operation of automobiles. However, the rapid diffusion of the exhaust gases and the thorough mixing they receive by the action of winds and air currents so dilute this noxious gas as to make it entirely harmless.

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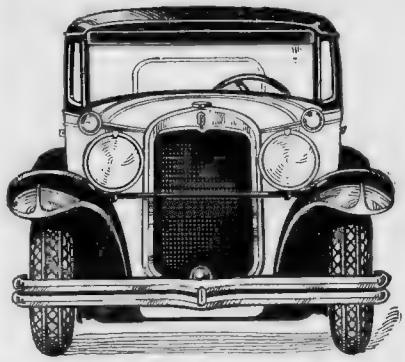

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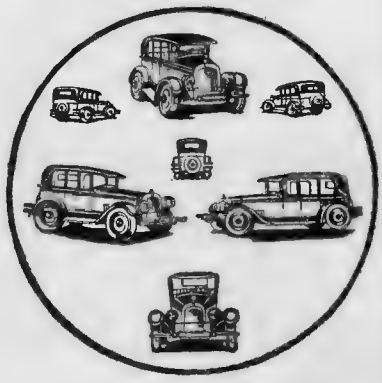

There are 7 cars in the circle. By drawing 3 straight lines you can put each one in a space by itself. It may mean winning a prize if you send me your answer right away.

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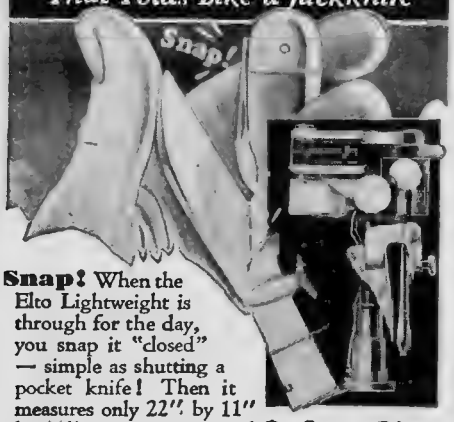

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Monobasic Acids

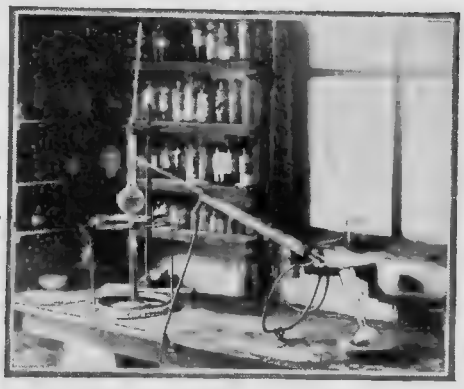
By Dr. Ernest Bade, Ph.D.

(*Continued from page* 48)

It melts at about 16 degrees C. and boils at 119 C. for the pure glacial type. One per cent. of water lowers the melting point about two degrees C. The melting point is best noted when, after freezing, from one-quarter to one-half of the acid has melted.

Propionic acid is most readily obtained by the oxidation of propyl alcohol with potassium bichromate and sulphuric acid. Then, too, it may arise under certain conditions on the fermentation of glycerine and sugar. The acid mixes with water but it may be separated from its water by the addition of calcium chloride, it then floats on the surface as an oily layer.

There are two forms of butyric acid, the next member, both of which are found in



The butyric acid is distilled in order to purify it still further. The above photograph shows this process being carried out.

nature. Normal butyric acid is found in butter in combination. When butter turns rancid, the free acid is formed. The other form, which is known as isobutyric acid is found in the root of the aconite and other plants.

Butyric acid is most readily prepared by fermentation. Make a solution of sugar, starch or glucose, about ½ pound to a gallon of water, 5 grams of ammonium tartrate, 5 grams of potassium phosphate, and a half a gram each of calcium phosphate and magnesium sulphate. Add a few good lumps of putrid cheese and a glass of sour milk and keep the mass for a few weeks, in a warm place at a temperature of 35 to 40 degrees C. The free acid is formed which, after a time, arrests the fermentation. This is a comparatively small yield. To increase it, precipitated or powdered chalk is added to the solution at the time it is prepared,

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about ½ pound for the quantity specified The mixture is stirred daily. It will become more or less thick after about ten days. Then gas is given off and the final product is obtained at the end of five weeks when fermentation stops. Then one pound of sodium carbonate is added and stirred into the solution. Filter through cloth to remove the calcium carbonate (chalk). Evaporate the solution to a quart and add one pound of sulphuric acid slowly. The butyric acid will be found on top of the solution as an oily layer. Add a few drops of sulphuric acid to the butyric acid and distill. Remove the last trace of water with fused calcium chloride and distill again. Pure butyric acid comes over at 156 to 163 degrees C.

Artificial Snow for Indoor Winter Amusement Palaces

(*Continued from page 32*)

whole of the floor, and a much larger room which this led into, arranged for various exercises, astonished you still more. Here there was a floor covered with artificial snow about 100 square meters in area, which was overhung by a balcony on which a Swiss ski teacher was established to teach his scholars the fundamental rules of the difficult sport. The cellar of the London ski school was neither artificially cooled nor warmed, so that the beginners, as well as those advanced in ski running had the satisfaction of training themselves by the approved training methods at ordinary room temperature.

Salt Becomes Snow

IT is to be remarked about the so-called artificial snow, that we are not dealing with a preparation, which in any way by its physical peculiarities can be compared to natural snow as this could be compared to artificial ice, but it has the general resemblance of snow, and in reality is a peculiar combination of salts which contains about 65 per cent of soda. By the strong opalescence perceptible in the larger crystals one assumes that in the product there are both sulphates and carbonates. The artificial snow is about three and a half inches thick on the level floor, and about two inches deep on the inclined course, where the stripping of the layer of snow is prevented by a specially constructed mat underneath it. In any case, the artificial snow is singularly like the natural snow in its mechanical peculiarities. When, for example, in going down the course, a beautiful "Telemark" (turn) or Christiania (another kind of a turn) or various leaps and circuits are tried by skilled ski runners, a dust cloud is produced exactly as with real snow. Falling on the artificial snow is no worse than on natural snow, so that the fall is soon forgotten and the salt crystals sticking to the clothes are quickly shaken off. The artificial ski track can also be used for sleds or toboggans with their flat runners, which gives an extension of the sport program.

After the first three months of the opening of the London ski school showed 1,000 hours of instruction by the ski master, the superintendent of the Public High School courses of the German Government Open Air School for Athletics was inspired by personal observation and practical testing to try the availability of the new invention and this led to a completely satisfactory result. Accordingly in Berlin, in one of the largest exhibition halls of the Home and Foreign Exposition, the largest snow sport attraction of the European continent was constructed with a gigantic artificial snow landscape which on a surface 130 meters (426½ feet) long and 20 meters (65½ feet) wide, had snow hills with various cross ridges for leap-

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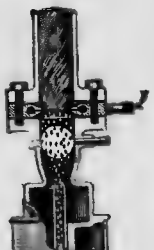

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ing, a special leaping course and two toboggan slides. Not less than 200,000 kilograms (440,000 pounds) of the artificial snow were used to cover the 300 square meters (3,229 square feet) of the surface of the improvised mountain landscape. The taking-off place of the great jumping course was at an elevation of 15 meters (49 feet) which started off the course at rather a steep angle at the edge, so as to get the requisite speed. This was the high point of the highest development of ski sport on the new artificial track, which subjected the Ayscough artificial snow to its most difficult test. In the future, in summer as well as at any other time of the year, one can go skiing and tobogganing; keep in training, or take the requisite technical instruction, so that at the proper time on natural snow the acquired ability can be proved practical and carried to a higher development. Good as the so-called dry ski tracks are, yet one thing is missing, the principal, the impressive moment, which cannot be found on the artificial ski tracks.

Artificial Snow Lasts

SMALL toboggan slides and ski courses can be built anywhere because the artificial snow is cheap and lasting. A renewal is very seldom necessary, and only little has to be used, because all that is lost is what sticks to the feet of the patrons and tracked about outside of the course. The crystalline artificial soda snow can be regenerated to a certain degree. Intervals in the sport and hours after the palace closes can be used to sprinkle the hygroscopic mass with water, after it has been raked over lightly. This returns it to its crystalline form. For the building of the artificial miniature mountain landscape in Berlin, the framework was of wood with the use of the so-called St. Andrew's Cross for trussing the supporting frame and beams.—By Engineer *Kirsch.*

Ancient Versus Modern Wonders

By Joseph H. Kraus

(*Continued from page 23*)

The Mausoleum of Halicarnassus

BENEATH the Statue of Zeus, there is a picture of the Mausoleum of Halicarnassus, as reconstructed by an artist from the best drawings and records obtainable. This was built to the memory of King Mausolus of Caria, after his death in the year 353 B. C., by Artemisia, his widow. Unfortunately, Artemisia did not live long enough to see the completed fruits of her labor. Nevertheless, the work was carried on by the foremost sculptors of ancient times, and it became one of the wonders of the world. Halicarnassus is a town in Asia Minor, and if you would like to find its location, look for the city now known as Boodroom.

The Pharos Lighthouse

PTOLEMY the First, erected a famous lighthouse on a rocky island off the African coast called Pharos. This lighthouse was of great height and its base was 100 feet square. The Island of Pharos was connected by a causeway to the mainland when the city of Alexandria was founded by Alexander. This causeway was 7 furlongs or 4,620 feet in length. The lighthouse remained standing for nearly 1,600 years, but was destroyed by an earthquake early in the fourteenth century. And so, the Pharos lighthouse remained for many years as one of the world's seven wonders.

The Pyramids of Giseh

IN past issues of this publication the various methods, one or more of which were probably employed by the Egyptians in the building of the pyramids at Giseh, Egypt, were described. According to Herodotus, approximately 100,000 men took 20 years to erect the great pyramid. Its base covers 13 acres and its apex is 451 feet above the ground. The great pyramid contains 2,300,000 stone blocks which have an average size of 40 cubic feet, and weigh 2½ tons each. However, some of the stones in this pyramid weigh as much as 50 tons each. The blocks were fitted and squared with an accuracy seldom equalled even to-day. How they were hoisted into place is not definitely known, but one of the methods hinted at by modern scientists is that probably a long ramp of earth was built, and the stones rolled into place on wooden rollers with slaves supplying the energy. Another suggestion was that the sides of the pyramids were smoothed and filled, and the stones dragged up the sides by cables going over pulleys at the top. Inside of these pyramids are immense chambers and halls, which will continue to be a source of interest for many years. Of course, the pyramids are still standing.

The Colossus of Rhodes

MANY of us have read of the Colossus which stood 'astride" of the entrance to the harbor of Rhodes. There is no scientific foundation for the conception that this "astride" position actually existed. It is well known that a bronze statue of the Sun God, Helios, about one-third the height of the Statue of Liberty, stood at the entrance to the harbor. This 50 foot Colossus was destroyed by an earthquake and later sold for old metal.

Temple of Diana

AND now we come to the last of the seven ancient wonders. This is the Temple of Artemis at Ephesus in Asia Minor, also known as the Temple of Diana. Diana was the Goddess of Fruitful Nature and this temple was dedicated to the worship of her and was completed about the year 400 B. C. It was built of Parian marble and excavations made in 1867 disclosed many interesting and important details regarding it. This temple was ransacked and burned by the Goths in the year 262 A. D. Since 1867, excavations in and around the temple have increased our knowledge of this, the last of the ancient world's seven wonders.

The Modern Wonders

THIS writer does not care to sit in the tribunal which will judge and classify the importance of the modern wonders. While we may say that electricity is a modern wonder, we have to classify and subdivide this even further. Just what do we mean by stating that electricity is a modern wonder? Lightning, a definite form of electricity, has existed from time immemorial. Do we refer to electric lights, power, heating, ventilation, electric locomotion, or do we refer to the electricity which keeps the spark of our engines alive, and thus permits of the operation of automobiles or the electricity which carries our voice through the air or over telephonic wires, or that which operates our X-ray tubes. It is obvious that the classification has to be a little finer than just the employment of one word, and yet it must be so immeasurably coarse that it will encompass many other ramifications of the same general group. An attempt has been made in this portrayal of the modern wonders to include those things it would be difficult to do without. It is true that we could do without the skyscraper, the telephone, the telegraphic system and even our modern newspapers, but who would care to. We have come to depend greatly upon

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things which we meet in everyday life, yet all of these are developments of the past few hundred years.

Skyscrapers

OUR modern skyscrapers are one of the present-day wonders, yet without the development of steel skeleton frameworks, these skyscrapers could not be built. Without the elevators to hoist people up to the fiftieth story there would be no excuse for a skyscraper. It is scarcely likely that one could expect customers to climb to the top of a fifty-story building, nor is it probable that one would care to make the trip two or four times a day, if one had to walk. And we will find that the skyscraper is linked up with electricity, with steam engineering, with ventilating problems and with the development of the steel industry.

Transportation

OUR systems of transportation are a modern wonder. Transportation, of course, takes on many and varied forms. Horses and horse-drawn vehicles cannot be considered as modern wonders, but the modern steamship, a floating palace, is certainly a relatively new invention. Electric and steam railroads are younger than this country, yet they have been developed to a point where they have become indispensable to our daily welfare. The automobile is a modern wonder. With it, the distance from one end to the other of this country is considerably shortened. Not alone does it make life more joyful, but it is absolutely necessary to our daily welfare. Automobile trucks carry produce, automobile buses transport our citizens from city to city, and the pleasure car helps us to enjoy our vacations. Yet the automobile would be of no avail would we not include the science of road building and maintenance. The automobile could not exist in its present form if its various electrical additions were not present. So here again is a modern wonder which is linked up with a great many different other wonders, and they in turn branch out like the roots of a tree. The rubber for the tires enters into the rubber, chemical and arboreal industry. The upholstery reaches into the textile and leather industry. The paints enter into the chemical and agricultural divisions, and the metals branch out into the electro-chemical, the chemical, the metallurgical, and the engineering divisions. Our plate glass is a modern wonder and must also be included in just this one branch of the automobile industry.

A photo shows a tug-of-war existing between two steam locomotives and an electric engine, which battle was won by the electric monster.

Rather than be broad, we shall attempt to be a little more specific in further classifications.

Radium: One of the illustrations shows a radium emanation apparatus for gathering emanation from a quantity of a radium salt dissolved in distilled water and locked in a safe. The gas from the radium is collected, sealed in glass tubes, and used for medical treatments.

The X-ray: An illustration shows the gigantic X-ray apparatus at the General Electric Works, Schenectady, N. Y., where experiments are being conducted with these superpower X-rays. *Electric Power*: Alongside this illustration there is the hydro-electric power plant at Niagara developing enormous electrical horsepower day after day.

Aviation: A final modern development shown in the top photo on the page is the science of aeronautics. The airplane has just passed its twenty-fifth birthday since its first experiments by the Wright Brothers at Kitty Hawk, North Carolina. Already airplanes have encircled the globe.

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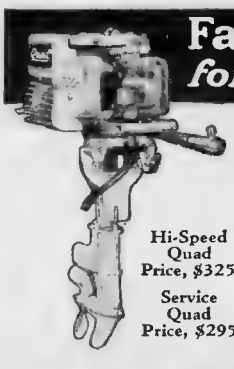

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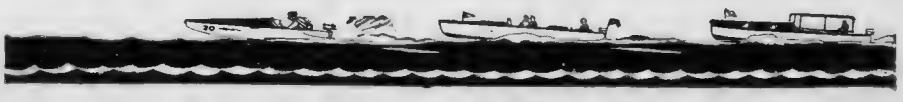

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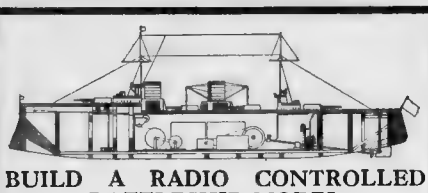

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We must also include radio as a modern wonder. Already it has been the means of saving untold thousands of lives. It has been the method for keeping us in constant communication with this vast world, and establishing more friendly relations with our neighbors. Last but not least, it has sent right into our homes a source of amusement difficult to duplicate by any other known means. And when we speak of radio, we must include television. *Television* is the newest of sciences of which we know.

Microscopy and *astronomy* both must be added. The microscope which enables us to see things smaller than can be seen by the naked eye, has increased our knowledge of disease and illness. It has helped us in metallurgy. It has developed in us a better knowledge of medicine—a knowledge of the very nature and construction of things about which we heretofore knew nothing, and as the microscope has sent us down into the invisible depths; the telescope has taken us out into the invisible regions of space. It has increased our knowledge of the universe and showed us a galaxy of stars, which constantly increase as the size of our telescope increases.

Then there is *modern chemistry*. Without it, there would be no rayon industry; in fact, without chemistry, many of those things necessary to our welfare would suffer an inferiority complex.

And last among the modern wonders, *modern surgery*. But modern surgery would never have existed were it not for the truly modern wonder, anesthesia. Anesthesia has saved the lives of countless millions. It has made the high-class surgery of today possible.

In conclusion, we would say that you might have a list of modern wonders even superior to those the writer listed. It is indeed difficult to choose any fourteen wonders which will completely encompass all of our modern sciences. The writer is well aware that anthropology, psychology, the newspapers, the telephone, and the mails; the lumber industry, the sugar industry, the corn and wheat industry, and hosts and hosts of others could give subjects which have not been included in this modern classification but an attempt has been made to list the most important ones. It is for you to judge the value of their relative importance.

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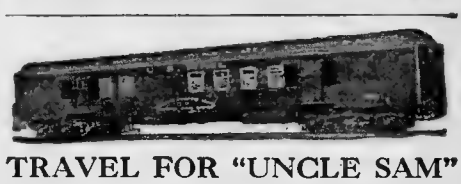

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Einstein's New Theory

by Prof. H. H. Sheldon

(*Continued from page 39*)

developments in science depend upon it.

New Theory

SKIPPING over his correlation of space and time, and other achievements, let us examine his latest work. The earliest reports from Germany were to the effect that he had shown that gravity was an electro-magnetic phenomena. As the paper which he had written came over the cables, however, it was clear that this was not the case. He had derived an equation which fits the facts of both gravitation and electro-magnetism; just as Maxwell derived one which fits the facts of light and electro-magnetism. As he has long ago shown that light has mass and that energy and mass are interchangeable, it is not a wild step of imagination to conclude that it is quite likely that gravitation is in reality electro-magnetic. Thus we have energy, mass, light, gravitation, heat, electricity, and magnetism all tied up as inter-related and interchangeable phenomena. In fact they appear to be different manifestations of one and the same thing.

They all appear from the most recent experiments to be of the nature of wave phenomena. Thus we, ourselves, appear to be made up of a bundle containing an enormous number of waves. Say we have no real existence if you like; say we are shadows of four-dimensional creatures in a three-dimensional world, if it pleases you so to speculate. No one can say you are wrong. On the other hand if you find the idea depressing, as some do, continue to think of yourself as a creature of flesh and blood; for you are just as real as you ever were, regardless of Einstein. And there is exactly the same chance of a heaven and a hell as there ever was; although it appears that the latter has fallen out of favor with the more modern religious thinkers. If one cannot see anything to reverence in the complexity of a universe so formed of waves, his imagination is unduly dwarfed.

Significance of New Discovery

BUT all the other correlating discoveries have meant much in new commercial developments. What can we expect from Einstein's work? We can block off heat and light, we can insulate electricity, we can direct the lines of flow of magnetism. Can we in any way insulate or control gravitation? Einstein's work will lead to a great deal of investigation. Perhaps we shall next measure the speed of gravitation by observations in tides. From that and other experiments we shall learn a great deal about it. If our knowledge ever extends far enough to show us a method of insulating it, our industrial world will get the biggest jolt it ever received. Aerial transport will be the only kind to be considered. If we could reduce its effect on ourselves to one-tenth its present value the effect would be astonishing. With our present muscles we could easily jump forty or fifty feet into the air. But the possibilities are obvious even to the most prosaic of individuals. And they seem as likely as did 500,000 horse power electrical stations in the time of Oersted, or as television in the time of Maxwell. Is this the age of discovery? We are barely out of our cradle. We have discovered but a few toys lying near us on the floor. And with these we think we are accomplishing miracles.

WHAT EXPERTS SAY

A Professor of Electrical Engineering Speaks

EVERY reader of SCIENCE AND INVENTION is unquestionably interested in the practical outcome of Professor Einstein's hypothesis or formulation. He is certainly preparing the way for more marvels in scientific progress and for that alone he is entitled to our grateful appreciation. It is a splendid privilege to be living in our modern age of tolerance and liberal mindedness. We not only regard with calm consideration the apparently unorthodox in mathematical and scientific hypotheses, but we are eager to add our contribution in helpful collaboratum.

Professor Einstein has subjectly evaluated his mental labors when he states that experience is the test of his mathematical formulations.

What the majority of us desire are practical applications. For us, the acid test of scientific and mathematical discovery is practical utility.

There seems to be no valid reason why there should not be a mathematical equation formulating the relation between a gravitational and an electric or a magnetic field, when the visible physical relations are so obvious in nature.

We neutralize the gravitational field of the earth when we allow a current to flow in the windings of a vertical solenoid, and lift an iron core within. When gravity is allowed to pull the iron core downward, a current might flow in the closed circuit of the coil.

A conductor having a small mass stretched over the surface of the earth might float in the earth's gravitational (and magnetic) field, if an electric current should flow through the wire; in the proper direction.

A horizontal windmill with a vertical rectangular (or circular) coil of say aluminum wire, attached to it, falls through the atmosphere. The windmill revolves the coil in the earth's field and an alternating current flows (or is induced) in the coil.

Reverse the operation; send an alternating current (of proper frequency) through the coil, the windmill turns and the device tends to rise in the gravitational field.

If Thales in 400 B. C., could give a practical demonstration of the relation between gravity and an electrical field, when he lifted bits of paper by electrified amber; there should be no objection to Professor Einstein's putting the relation in mathematical form.

(Professor) T. E. Austin, Hanover, N. H. Formerly Professor of Physics and Electrical Engineering in Dartmouth College.

Prof. Charles Lane Poor, Famous Astronomer, Objects to Einstein Theory

MY objections to the original Einstein theory still hold, and are becoming recognized more and more as valid. There is absolutely no observational proof of the theory; the basic postulates of the theory are not involved in any one of the experiments thus far made. The eclipse observations involve only one minor postulate, and the actual observations do not furnish any conclusive proof even of this single assumption. For these observations can be explained just as well by purely physical causes.

Neither Einstein, nor any relativist has yet suggested a crucial experiment, which involves the truth or falsity of any one of the basic postulates of the theory. And it would seem to be a simple matter of logic, that no theory can either be proved, or disproved by experiments which do not involve that theory.

(Prof.) Charles Lane Poor,
Dept. Astronomy,
Columbia University.

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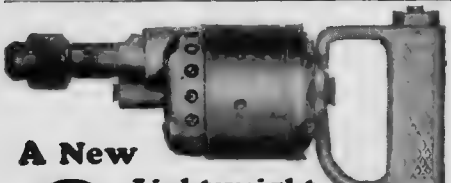

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Home Movies

By Don Bennett

(*Continued from page* 45)

your camera) showing the position of the slide for various degrees of cut-off.

'Extra slides may be cut out of thin fibre, black or red, with a variety of holes in them for different effects. You can make a keyhole, binoculars, several sizes of circles, diamonds, hearts and a hundred and one other shapes that will suggest themselves to you. Remember, though, that if you use the shape itself in the mask, you will get an entirely different result on the screen. Binoculars are made by two small circles spaced about a quarter of an inch apart, hearts are made by two circles and a triangle placed about the same. Small circles will be several times larger on the film. Above all, the holes must have absolutely clear edges or the film will be hazy and indistinct (Fig. 8).

"Some means should be provided for setting the camera in the same place each time so that the registration of film and the attachments will be the same in every scene. Perhaps the simplest way to do this is to fasten a strip on your tripod head which will align the camera. If you use a wooden head tripod, this should be easy, while with the metal head tripods so many amateurs use, an extension of the supporting rods of the attachment will serve the purpose."

Mr. Jones ended his remarks.

"Gentlemen, I think we owe Mr. Jones a vote of thanks, and as chairman of the production section of this Club, I here and now voice my personal thanks in addition to extending those of the Club."

"I'm very glad," Mr. Jones said, "that I can be of service to you Club members and I want you to feel free to call on me with your problems. I must go now, but here's wishing you 'Good shooting.'"

(Next month ways of making wild life pictures will be described, with directions for setting day and night "traps." The use of telephoto lenses and methods of fastening the camera will be described in detail.)

IN THE NEXT ISSUE—

Answers from eminent people to the question:

"IS A COLLEGE EDUCATION WORTH WHILE?"

5,000,000 Volt Man-Made Lightning

(*Continued from page* 28)

barrier, doubles in height upon reflection.

Natural Lightning

NATURAL lightning discharges are in order of 100,000,000 volts, and 100,000 amperes, and occur in a few millionths of a second. The wave shape of lightning has been pictured by the cathode ray oscillograph and the time required for a cloud to discharge has been measured by this means. The attenuation of lightning waves travelling on a transmission line have been determined, as well as the effects of laboratory lightning on insulators, transformers and protective devices. Four records of lightning discharges were made by the General Electric Co., at Pittsfield, showing the effect of lightning on short lines when storm clouds were at least a mile away. The measurements taken showed that a cloud may discharge in as short a time as two one-millionths of a second.

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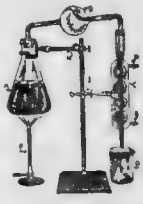

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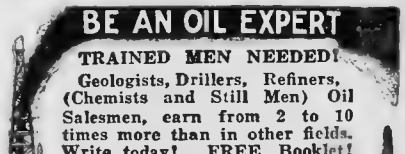
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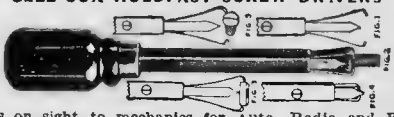

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The Origin of Man

By Dr. Ales Hrdlicka

(*Continued from page 13*)

hardly as yet, quite ready to do so in a simple, clear, definite manner. The real and direct evidence of human ascent is all comparatively recent.

II.—The Evidence of Human Evolution

THE established evidence of man's evolution may be divided into the indirect, the direct, the documentary, and that now observable. The first relates to what has taken place or is now going on, in respect to evolution, in nature and in other living beings than man; the second comprises the evidence presented by the composition, structure and functions of man himself; the third deals with the actual remains of earlier man; while the last shows scientific observations on evolutionary changes going on in man at the present time and with the indications for the future. Somewhat more in detail, the subject may be subdivided as follows:

The Indirect Evidence

1. Analogies in inorganic nature.
2. Evolution in all known organic forms.
3. Man's appearance on the earth at the right time of organic advance.

The Direct Evidence

1. Relation of various structures in the embryonic development of man to those represented by some lower vertebrates.
2. Similarities with other mammals in mode of conception, processes of development and growth in all vital functions, including those of the barren, in senescence when continuation of the kind is assured, and in death.
3. Physical similarities to identities in organs, limbs and all other physical as well as microscopic parts of the human body.
4. Close similarities to identities of the chemical constituents of the human body with those of other mammals.
5. The presence in man of many vestiges of or reversions to features regularly present in lower animals.

The Documentary Evidence

1. Man's cultural remains in relation to geology and paleontology.
2. His skeletal remains, in same relations.

The Observational Evidence

1. Man's changes, physical, functional, and mental, observable scientifically at the present time.

Evolution Universal

THE process of evolution is a basic universal phenomenon. Nature changes throughout, and these changes, taking place under definite laws, so long as they are constructive or progressive towards other forms, can only be called evolution. The whole cosmos, each star, each organism, and probably each particle of matter, is changing or is capable of change under due conditions, stability being only relative. No living being especially, it is now well established, is immutable, but all are capable of changes in the form of "adaptations" to changing conditions. The possibility of adaptation is, in fact, one of the basic and most vital properties of all organic beings. And every adaptation, every change of some consequence and duration in an organism, calls for adjustments, which if lasting, bring about needed and eventually inheritable modification in structure. Examples of all this are seen in great many wild, and especially in the domesticated animals, and useful plants, where man has knowingly assisted nature.

But changes of structure in any definite direction mean "evolution" in that direction. To exclude man and his ancestry from these basic conditions and laws would be to exclude him from the range of organisms, which, as will be seen later on, is manifestly impossible.

Thanks to the work of Leidy, Marsh, Cope, Osborn and other Americans as well as European paleontologists, it is now possible to actually follow by whole series of specimens, not merely structural adaptations, but progressive evolution of an increasing number of phyla of animals, over great lengths of geological time. Perhaps the best example of this is in the case of the horse, which is known in many stages from an ancient little four-toed suggestion-of-a-horse to the fine racer and the other forms of today. But a little less known is the evolution of the camel, and much is known already about the dinosaurs, proboscidea, some of the carnivores and still other forms, and there is much evidence of similar nature on the invertebrates such as the Ammonites and Nautilus among the Cephalopods, the Acatinelas and Partulas among the Molluscs, etc., and on plants (Dicotyledons, Conifers, etc.)

Evolution, though not always of the same type or pace, and though greatly influenced by environment, is in living beings as universal a process as life itself. Without it there could be no variety in organic beings, there could be no progressive adaptation to conditions, and there could have been realized no man.

Man's appearance on the earth at the right time of organic differentiation, is of course a very important piece of evidence as to the nature of his origin. As the top bough of a tree, so he appears only after the preceding parts or forms have reached the proper grade, a grade of development every onward step of which must be in the direction of the human.

The Embryological Evidence

THE human being begins precisely as any other vertebrate. Yet this beginning, and the following stages of embryonal development, constitute a great array of wonderfully intricate and consequential processes which could never be duplicated accidentally. To the student with the microscope the organic unity of man, with the rest of the living beings and especially with the rest of the mammals, is indeed a fact, a fact so plain and complete and great that it alone is quite sufficient for a deep conviction of unity. Even human heredity, that vastly complex endowment of each one of us, is carried by the same clusters of molecules, or "chromosomes," in each germ cell, human or mammal.

In addition, the human embryo shows at various stages traces of prehuman characteristics that disappear or are reduced to rudimentary condition in the course of subsequent development. These matters are too techniacl for a general discussion, but features that may be mentioned are the initial primitiveness of the hands and feet, the rudimentary tail which persists in the human embryo, up to and even over the ninth week of prenatal age, the hair covering of the body, etc.

Physical, Functional and Chemical Similarities

THE fully developed human body is, organ for organ, function for function, and

NOTE: Those who may wish to read further on this subject may be referred to the writer's article on "The Evidence Bearing on Man's Evolution," Smithsonian Report for 1927, pp. 417-432; and to publications referred to in that article.

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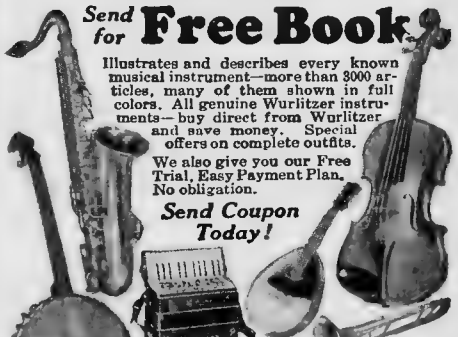

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chemical constituent for constituent, so near to that of other mammals and especially the anthropoid apes, that the fundamental unity of all is only too clearly apparent. Great or small, simple or complex, there is nothing in man a counterpart of which, though modified more or less according to the needs of the species, would not be found also in other mammals. The differences are only in secondary characters, such as size or exact shape of the parts, acuity or duration of a function, a little plus or minus chemically. This is true even to the brain which, while relatively larger and more complex as well as efficient in man, in some instances and some directions immensely more efficient, is still in all essentials, even to the kinds and arrangement of brain cells and localization of nervous centres, much like the brain of any of the higher anthropoid apes and other mammals. A great deal of direct value to surgery of the human brain has been learned from observation on brains of apes and dogs.

Vestiges and Reversions

EVERY human being carries more or less hidden in himself innumerable material reminiscences of his pre-human ancestry, and that sometimes from extremely far back. His canines, his coccyx, his appendix, the "Darwin's tubercle" occasionally found on his ear, the arrangement of the hair over the limbs, supernumerary breasts, certain occasional characteristics of his toes, of his viscera, of his muscles, of his bones, of his incisor and molar teeth and now and then even of the brain, are vestiges of prehuman conditions, and features testifying conclusively to man's ascent from lower creatures. To which may be added the occurrences of multiple births in man; the quadropedal progression for a time of some children; and many other conditions, including even some mental phenomena, such as the instincts. In this line alone, again, there is evidence enough of man's true origin and of his biological history to satisfy any earnest inquirer.

Remains of Early Man

THE documentary evidence of man's more humble origin and gradual differentiation is still far from complete; yet it is already so respectable that it alone in turn suffices to substantiate human evolution.

When Darwin wrote his "Origin of Species" and "Descent of Man," a man's prehistory was barely beginning to be known. Today, cultural remains of early man, in the shape, especially, of stone implements, are known literally by the hundreds of thousands, extending far back into the Ice Age. They occur in quantities in ancient caves and deposits and in the glacial river terraces of western Europe. They are found associated with bones of various extinct animals which help to date them. And they show phases of workmanship which, together with the criterion age, enable the student to classify them into a progressive line of development. Here is a great mass of evidence that may be easily seen in the European and even our Museums, or in the field where, especially in France, under government regulations and guardianship, whole sections of the implement-bearing strata are left as archeological monuments; and if so desired such implements may even be collected first-hand. Here is no room for any uncertainty. It is interesting to note that among the foremost European students in this line are men of the clergy; in fact the Abbe Breuil in France, is the leading pre-historian of our day.

In addition to the already innumerable cultural remains of early man, the European scientific institutions now possess also the skull fragments to complete skeletons of over one hundred prehistoric men and women, of demonstrably more than 20,000 years ago. They range from a portion of a lower jaw, as in the case of the important Piltdown find in England, to most of the parts of eighteen skeletons discovered at Predmost, Moravia. They come from ancient gravels, sands, or loess, from old caves and rock shelters or even deep down in hard stone, as in the quarries of Ehringsdorf, near Weimar, Germany. They are associated with and in instances overlaid by the bones of ancient elephants, lions, camels, rhinoceroses, and later with or by those of the mammoth cave bear, cave hyena, reindeer, extinct horses, deer and bisons. These human remains show various grades and forms of petrifaction; and in general the older they are the more primitive is their form and the farther away from modern humans.

Here is once more an undisputable line of evidence of human evolution, and in a large measure an actual illustration of the process. When an observer regards such specimens as the Piltdown or the Heidelberg jaws, and even some of the later ones from Krapina, he sees forms that, were it not for the teeth and other parts of the skeleton, he could hardly believe were really human; and much the same is true of the Neanderthal, the Gibraltar, the Rhodesian skulls. But the skulls all show already a fairly large human brain, and the teeth with the bones of the body are those of man.

It may be interesting to note that while the originals of these precious skeletal remains are scattered over Europe, they or at least the main part of them, may be seen collectively, in exact replicas, in two of our American institutions, namely the National Museum at Washington and the American Museum of Natural History in New York; while more limited series are possessed by all larger Museums that include the subject of Man. Moreover, they are now being added to every year and, were it not for the great difficulties of finding the means for exploration in these lines, far more even could be accomplished. It is not generally known that since 1920 a selection of American college men and women go, under proper scientific guidance (The American School for Prehistoric Research) to Europe each year, to see, as much as possible first hand and to actually participate in the excavations.

In view of all this documentary, available and incontrovertible evidence, and the many publications in all languages in which it is dealt with, doubt as to man's origin and gradual rise from the organic realm can, to those who know the facts, no longer exist, even though many important details are still to be uncovered.

The Current Evidence of Man's Evolution

THERE is, further, ample evidence that evolution in man is still active and progressive. Man, notwithstanding his inborn conservatism, is physically and mentally as responsive to the environment and demands of the present, as he ever was to those of the past; the only important difference being that, on one hand, the effects of the natural environment are largely neutralized now through man's artificialities, while in its place are developing factors of his own making.

Concluding Remarks

THAT, briefly, is the evidence of man's evolution. It is easy and profoundly gratifying to understand it when there is an understanding, imperfect as it still must be, of Nature as a whole. To be the chief product of a great life-flood of millions of years duration, feels good. Here is a true substantiation of man's elevated position in the organic world. Ages have labored and built to produce him, an appreciation full of proud consciousness and responsibility. And what is the best is that with this light on his past, coupled with that of his present, he feels, he knows, that he is still unfinished, still progressing, and that ages of further development are still before him.

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Space, Time and Relativity

By Donald H. Menzel, Ph.D.

(*Continued from page 40*)

P: First we shall have to choose an accurate clock.

R: Accurate? How do you know that it will be accurate?

P: I shall check it daily by the stars—the rotation of the earth.

R: Then if the rotation of the earth is uniform, all well and good, but if it should vary, all kinds of errors will be introduced. We should find the sun, moon, and planets apparently not keeping their predicted places.

P: In that case we should be able to correct for any variation of the earth's rotation.

R: And such an effect has recently been detected.* Professor E. W. Brown, of Yale, was able to explain away certain hitherto mysterious discrepancies in the motions of planets as an error of terrestrial clocks, due to an alteration of the earth's rate of rotation. But to correct our clocks accordingly, means shifting the standard for time measuring from the earth to the planets. What assurance have we that their decision is superior?

What Is Uniformity of Motion?

P. We have a law of physics that prescribes their uniformity of motion.

R: And what is uniformity of motion but that the object moves a given distance in a given time? Do you not see that you are again reasoning in a circle? You cannot logically set your watch by the rising sun and then use your watch to see whether or not the sun has risen on time. We must choose some standard and then refer everything to the standard. One fact, at least, is emerging from our discussion. For time to progress there must be both matter and motion.

L: But surely time is going on just the same, even when I am perfectly motionless—asleep for example.

P: Of course it does; but are you perfectly motionless? Your heart is beating; you breathe; blood flows in your veins.

R: Suppose that everything in the universe should suddenly stand still—all life cease, the planets pause in their orbits, atoms and electrons stop. Time also would be suspended and when motion set in again, it would seem but the next instant and we should be entirely unaware of the occurrence. To make my illustration a little more graphic, suppose that there is just one person who does not suffer from this universal paralysis, and is thus able to count the lapse which amounts to say ten days, by his watch.

L: Then he could tell us about the experience.

P: True, but would you believe him? Suppose a man came up to you and said: "You have been standing here motionless for ten days." What would you think?

L: I'd think he was insane, I guess.

R: Yet it has been recently suggested by some scientists—though the hypothesis is tentative, daring, and unproved—that time, instead of progressing uniformly, goes by fits and starts, discontinuously, so to speak.

L: But is that not contrary to experience?

R: This wall before us appears to be perfectly solid and continuous—according to human experience. Yet scientists have proved that its apparent solidity is an illusion, for it is built from minute particles. To us it appears smooth and solid. To a being a billion times smaller it would seem more porous than a sieve. Experience is a poor judge to tell us the nature either of space or time.

P: According to that theory the continuity of existence is as much an illusion as the smoothness of the moving picture. If it is correct, our life is just a rapid succession of stills.

R: We agree, then, that a world without matter or motion is a timeless world. This is rather an important point. We used to conceive of time as entirely divorced from space and matter. Our geometry was one of space alone and time followed a law of its own. Einstein has shown us how they are connected! He discusses a world of four dimensions—three of space and one of time.

P: Has Einstein really discovered the hitherto mysterious fourth dimension?

Simple Explanation of Fourth Dimension

R: That depends largely upon what you mean by the expression "fourth dimension." If you refer to its restricted meaning—*a spacial extension in a direction perpendicular to the three familiar ones,*—the answer is no.*

The world of three dimensions deals with geometrical relations alone, *size, shape, distance*—a static sort of universe. Einstein's world of four dimensions is a world of events.

L: Can you make it clearer?

R: You may say, "I met Mr. Brown on the tenth floor of the XYZ building at the corner of Second and Main streets," and you have specified a location in space. If you add—"At ten-thirty this morning" you have specified a location in time and space, i.e., an event. The three dimensional world is composed of points, lines, surfaces, etc. Similarly, Einstein's theory deals with events, which are four-dimensional because four numbers, three of space and one of time, are necessary to designate an event. There is nothing new or mysterious about this. Mr. Smith drives his car down the street at sixty miles an hour. The Geometer will draw a picture of the street and show how the car has progressed along it. (Fig. 1.) The Relativist realizes that they have progressed in time as well as space. He takes two axes—one to represent space, the other time, and pictures Mr. Smith's car as progressing through both at once. (Fig. 2.) Any given point on the line, say A, tells what time Mr. Smith has reached a given point in space; it specifies the event A. The succession of events indicated by the line is known as the "world line."

P: Are there any new conclusions to be derived from this reasoning?

R: Many. Here is one that seems particularly interesting. Let us suppose that an astronomer who is observing Mars notes a flash of light at 9:00 P. M. exactly. He concludes that a Martian is signalling and sets himself the problem of calculating exactly when the message was sent. How would you proceed to solve such a problem?

P: How far away was the planet?

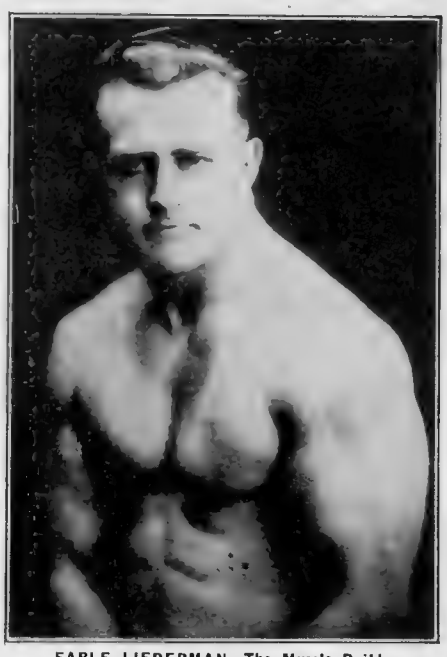
R: Say 186,000,000 miles.

P: Well, since light travels 186,000 miles per second, it would take 1000 seconds to reach us. Therefore the signal was sent 1,000 seconds before 9:00 P. M. or 8:42:20 P. M.

To be concluded in the June number of SCIENCE AND INVENTION)

*Editor's Note: A full discussion of the discovery was given by Dr. Menzel in SCIENCE AND INVENTION, March, 1927.

*See the first article of this series.



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Insect Cradle Builders

By Dr. Ernest Bade

(*Continued from page 33*)

of the leaf remaining on the outside, the leaf is rolled from the bottom upward, forming a cone. The rolling is accomplished by means of its legs. Finally the female snout beetle crawls within the cone and tightens up the structure. In the upper part of the leaf surface, tiny pockets are gnawed, and in these eggs are deposited. This will usually be near the center of the cone, but the cone is usually rolled after the leaf has become slightly wilted as it can then be handled by this insect more readily. When the leaf is finally rolled, or if a number of them have been rolled together and after the eggs have been deposited, the beetle returns to the main vein where the curved cuts end and cuts the petiole still further so that practically no sap can flow. The leaf mass then attains the property of supplying food to the hatching young and when the larvae are large enough and are ready to pupate, the dried-up leaf falls to the ground, the larvae emerge and build a pupating chamber in the ground, where they remain until they are ready to emerge as full grown snout beetles.

The mathematical principle upon which the construction of this cradle depends, lies in the S-shaped cut or involute. This curve, called the involute, is described by the end of a thread gradually wound and unwound from a circular object. When the beetle makes this curved cut in the leaf, the best form of a cone or funnel is produced, and since the insect makes this cut in the early morning hours while the dew is still on the leaves, the leaf will begin to roll up of itself. Then, too, the two outside or cut edges fit closely together on their opening so that no rain can enter the cone. The tip of the leaf is bent upward so that this end is tightly closed.

How Bees Build Cells

THE cells of the bee are also built according to mathematical precepts. These are six sided prisms closed by three four-sided rhomboids, whose obtuse central angle form a flat three sided pyramid. Although mathematical principles are employed, no bee-cell is absolutely equal in shape and in form to its neighbor. In spite of this the cell uses its space to the best advantage and is the strongest structure that can be built with the least material. The stability of the cell is increased still further due to the fact that the bottom or ends, which are closed by the three rhomboid surfaces, are in just the right proportion. Here, on each of these surfaces, the short diagonal (A B in the diagram) is of the same length as the four sides. (AD, DB, BC and CA are equal to AB in length.)

The cell of the bee cannot be considered as quite ideal and as built with mathematical precision, although it does approach it quite closely. The sum of the outer angles through a section of the cell gives us 720 degrees and gives an almost perfect hexagon; almost, but not quite.

A contrast to the honey bee is the leaf-cutting bee which builds its cells from leaf fragments cut to size. These may be round or oval. The latter are used for the sides, the round ones as lids. The nests of this bee may be placed in the most varied of places. Some build them in the ground, others within the decay of a tree or branch while still others will be satisfied with any cavity that suits their fancy. They are not at all particular.

(*Continued on page 93*)

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Insect Cradle Builders

(*Continued from page 92*)

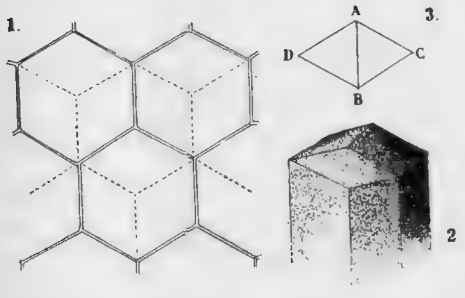
The Rose Leaf-Cutting Bee

THE rose leaf-cutting bee (*Megachile*) excavates a tunnel in the ground which may be four inches in length. This nest resembles a set of cars, for each individual unit is placed in front of the last until a whole string has been built. The individual cells are built from leaves cut to shape and they are so placed that they completely cover all of the ground of the excavation. There is not a crack to be seen. They form an outer and inner shell. To form these thimble-like cells, leaves of a particular type of plant are always used and each cell is most carefully and tightly constructed.

The rose-leaf wasp simply injects the leaf and makes it curl. The cone produced is shown above as well as the larval stage of this insect. The eggs are deposited on the edge of the leaf.

The cut leaves, the fragments of which are often three times the size of the bee itself, are carried between the legs to the cavity. Here they are rolled up and pushed into the cylindrical tunnel where they serve the purpose of cell walls. Quite a number of oval shaped leaf fragments are used as wall coverings, and the bottoms or ends of the cell are so made that the leaf ovals are bent downward forming a sort of a lid. These are still further tightened by the addition of circular sections of the leaf. Each end of the individual cell is only a partition and divides the entire cylinder into a number of chambers. This creature knows just exactly how large it should cut the oval and the circular pieces to make a tight fit. The entire structure seems as if glued together although no cement of any kind is used. The stability of the cells is attained by simply placing the leaf fragments tightly together.

Each individual cell is made by placing three ovals in the excavated chamber. At the seams, three more are placed and over these seams three more ovals so that a total thickness of nine layers of cut leaves form each cell. Each cell is closed by a number of circular leaf fragments cut to disks, by means of which the entire structure is made almost entirely invisible to the eye.



The above illustration shows at 1, *the hexagonal cell of the bee, dotted line shows the shape of the bottom cell,* 2, *the bottom of the cell,* 3, *the diagonal AB is of equal length to the sides of the triangular pyramid.*

How Wasp Builds a Cradle

THE rose leaf wasp (*Blennocampa*) is a leaf roller but this insect takes things more easily, It just deposits the eggs on the edge of the leaf and makes an injection at the spot. This causes the leaf to curl so that the eggs finally come to rest within a cone and the young, hatched larva feed on the leaf substance.

No particular cradle for the young is made by the leaf wasp (*Pamphilius inanitus.*) The hatched larvae take over this task. With their mandibles they cut narrow strips from the leaves and roll them into a spiral, spinning them into a tube. With increasing size, the tube is increased with new strips cut from the leaves. The rear feet of this larva are degenerated, probably due to their life within the tube, which is always carried with them. When the larva is taken from its house, it can not move about unless it spins a thread and then it moves along it. In the fall the home which it carries about with it is given up and the larva descends to the ground where it passes its resting stage. In the spring it emerges as a full grown adult insect.

The Caterpillar

THE caterpillar of the minute butterfly (*Tortrix Forskaleana*) makes still less work for its cradle. It just spins a number of leaves together to form an arch. It passes its larval stage under its shelter feeding upon the leaf masses found within easy reach. Should this tiny caterpillar be disturbed, it descends to the ground on a rapidly spun thread. Later, when the danger is passed it returns to its particular arch. When the time for pupation arrives, the caterpillar descends to the ground on such a thread.

Everywhere in life an urge is present to protect the young and defenseless. In many cases artistic structures are reared or devised based upon mathematical and scientific principles. It is true that the animals have no knowledge of mathematics, they just build them without knowing the why or wherefore.

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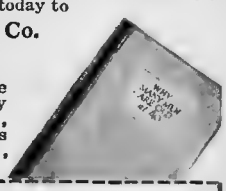

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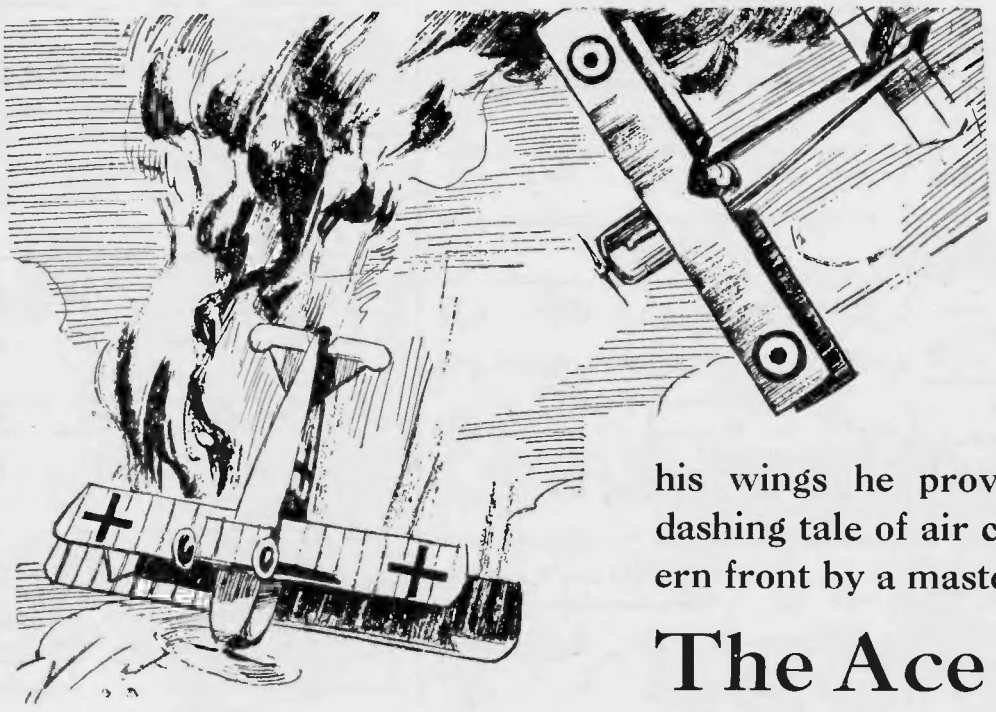

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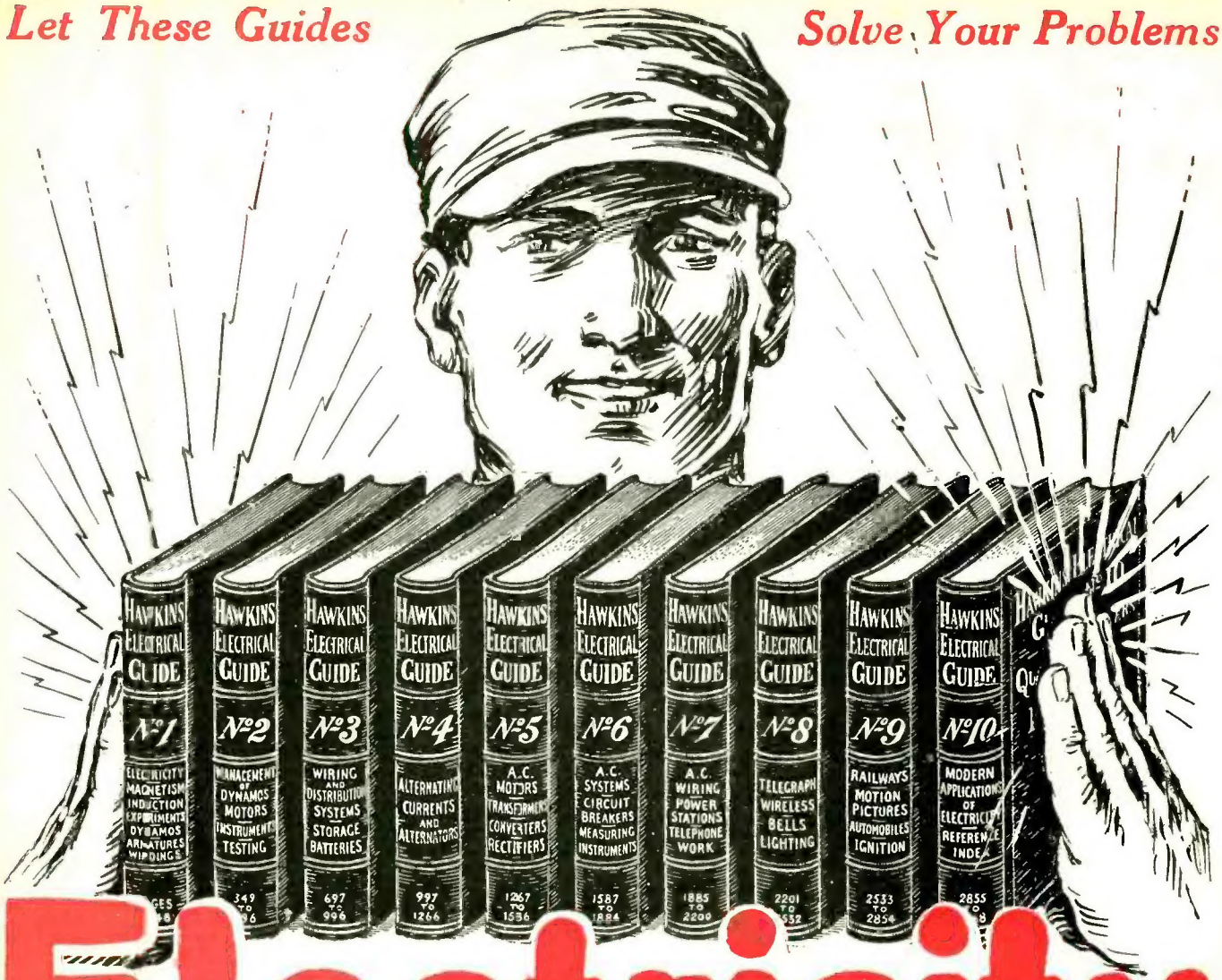

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